Weekly Focus: inequalities
Weekly Skill: solve and graph

LESSON 30: Inequalities

Lesson Summary: For the warm up, students will solve a problem about waterfalls. In Activity 1, they will practice one-step inequalities. In Activity 2, they practice two-step inequalities. Activities 3 and 4 are solving and graphing inequalities and word problems. There are two questions for the application question. Estimated time for the lesson is 2 hours.

Materials Needed for Lesson 30:

- Video (length 7:25) on inequalities. The video is required for teachers and optional for students.
- 2 Worksheets (30.1, 30.2) with answers (attached)
- *Mathematical Reasoning Test Preparation for the 2014 GED Test* Student Book (pages 68 – 69)
- *Mathematical Reasoning Test Preparation for the 2014 GED Test* Workbook (pages 94 – 97)

Objectives: Students will be able to:

- Solve the waterfall problem
- Solve one and two-step inequalities
- Solve word problems with inequalities

ACES Skills Addressed: N, CT, LS
CCRS Mathematical Practices Addressed: Reason Abstractly and Quantitatively, Mathematical Fluency
Levels of Knowing Math Addressed: Intuitive, Abstract, and Application

Notes:
You can add more examples if you feel students need them before they work. Any ideas that concretely relates to their lives make good examples.

For more practice as a class, feel free to choose some of the easier problems from the worksheets to do together. The "easier" problems are not necessarily at the beginning of each worksheet. Also, you may decide to have students complete only part of the worksheets in class and assign the rest as homework or extra practice.

The GED Math test is 115 minutes long and includes approximately 46 questions. The questions have a focus on quantitative problem solving (45%) and algebraic problem solving (55%).

Students must be able to understand math concepts and apply them to new situations, use logical reasoning to explain their answers, evaluate and further the reasoning of others, represent real world problems algebraically and visually, and manipulate and solve algebraic expressions.

This computer-based test includes questions that may be multiple-choice, fill-in-the-blank, choose from a drop-down menu, or drag-and-drop the response from one place to another.

The purpose of the GED test is to provide students with the skills necessary to either further their education or be ready for the demands of today's careers.

Lesson 30 Warm up: Solve the waterfall problem	Time: 10 Minutes

Write on the board: A majestic waterfall is Niagara Falls between Canada and the U.S., but the highest waterfall in the world is Angel Falls in Venezuela at 3,212 feet high. By comparison, Minnehaha Falls in Minneapolis is 53 feet high.

Basic Question:

- Angel Falls is how many times as high as Minnehaha Falls? Write as decimal and fraction.
  - 3212/53 = 60.6 = 60 6/10 = 60 3/5 times higher
- About how many yards tall is Angel Falls?
  - 3212/3 =1070.67 = about 1071 yards tall

Extension Question:

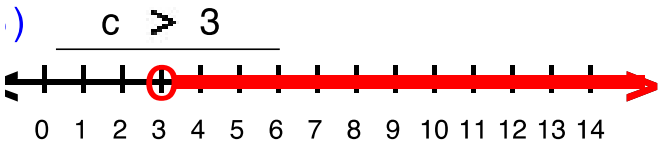
- Angel Falls is 18 times the height of Niagara Falls plus 98 feet. Write an equation to find the height of Niagara Falls.
  - Let h = height of Niagara Falls
  - 18h +98 = 3,212
  - h = 173 feet = height of Niagara Falls

Lesson 30 Activity 1: One-Step Inequalities	Time: 15 Minutes

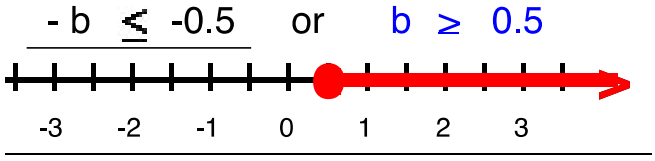
1. Inequalities look like equations without the equal sign.
2. Inequalities differ from equations in that they have more than one solution.
3. Instead of the equal sign, we use the symbols:
   a. $<$ for **less than** ex. $2<3$
   b. $\leq$ for **less than or equal to** ex. $5+6 \leq 11$
   c. $>$ for **greater than** ex. $3>2$
   d. $\geq$ for **is greater than or equal to** ex. $11 \geq 5 + 6$, $11 \geq 5 + 5$

4. Inequalities are solved similarly to equations. One difference is:
   a. **When you multiply or divide by a negative number, you do the inverse of the sign.**
   b. See how this makes sense with whole numbers. $-5 < -4$. If we divide both by -1, we see that now $5 > 4$.
5. Inequalities are graphed on a number line and may include positive and negative numbers.

6. Example A:
   a. My neighbor just got two new cats and now she has more than 5 cats.
   b. How many cats did she have before?
   c. Let c = the number of cats she had before.
   d. The number of cats she had before + the 2 new ones is more than 5.
   e. Set up the equation as $c + 2 > 5$.
   f. Solve $c + 2 > 5$. Subtract 2 from both sides to get $c > 3$. She had more than 3 cats before.
   g. Since the solution does not include 3, the circle above 3 is not filled in. It is left **open.**



7. Example B:
   a. Solve $0.75 - b \leq 0.25$. Subtract 0.75 from both sides to get $-b \leq -0.5$.
   b. Divide both sides by negative 1. $\frac{-b}{-1} \leq \frac{-0.5}{-1}$. $b \geq 0.5$
   c. Note that the sign was changed to the opposite because we divided by a negative.
   d. Since the solution includes 0.5, the circle on the graph is filled in. This is called **closed.**



Practice with **Worksheet 30.1**. Do a few together on the board first.

Lesson 30 Activity 2: Two-Step Inequalities	**Time: 20 Minutes**

1) Example A: Jeanette has $40 to spend on flowers. She wants to buy roses for $18 and spend the rest on lilies. Each lily flower costs $11.
   a. We write an inequality for the number of lilies she can buy, because there is more than one solution **and** she can spend up to and including $40.

Explanation:

x = cost of one lily flower

$11x + 18 \leq 40$

$11x \leq 40 - 18$

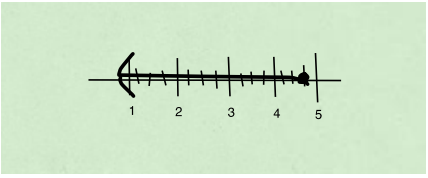
$11x \leq 22$

$x \leq 22/11$

x = 2 --> 2 is the most lily flowers she can purchase

2) Example B:

Rich has $60 at most to spend on clothes. He wants to buy a pair of jeans for $22 and spend the rest on T-shirts. Each shirt costs $8. How many T-shirts can he buy?

- We don't know how many T-shirts he can buy. Let x = number of T-shirts
- We know that jeans cost $22. That is the constant.
- Jeans and T-shirts can't be more than $60 but can also equal $60. This is why we use an inequality instead of an equation.
- Jeans and T-shirts ≤ $60.
- $22 + $8x ≤ $60
- 22-22 + 8x ≤ 60-22
- 8x ≤ 38
- $\frac{8x}{8} \leq \frac{38}{8}$
- $x \leq 4.75$
- The graph shows 4.75 or less including the 4.75.
- 

- Rich cannot buy part of a T-shirt so he can only buy 4 T-shirts.

Practice two-step equations with **Worksheet 30.2.** Do a few on the board together first.

Lesson 30 Activity 3: Solving and Graphing Inequalities	Time: 15 Minutes

1. Do the problems in the **student book pages 68-69.**
2. Review any questions that students found challenging.
3. Choose a few problems to have volunteer students do on the board.

Lesson 30 Activity 4: Independent Practice	Time: 40 Minutes

1. Have students work independently in the **workbook pages 94-97.**
2. Circulate to help. Review any questions that students found challenging.
3. Choose a few problems to have volunteer students do on the board and explain.

Lesson 30 Application Problems: Exit Ticket	Time: 5-10 Minutes

(Either write the following problems on the board, or print the exit ticket at the end of this lesson.)

Write inequalities to solve the following problems:

1. Pablo makes $300 a day and works 20 days a month, but he is fined $20 every day he is late. How many days can he be late if he wants to make at least $5,910?

   Answer:

   a. Let d = days he is late (fined)
   b. $300(20 days) – $20(days fined) ≥ $5,910
   c. 6000 – 20d ≥ $5,910
   d. -20d ≥ −90
   e. $\frac{-20d}{-20} \geq \frac{-90}{-20}$
   f. d ≤ 4.5 so he can be late 4 days only

2. A school has a budget of $240 per class to buy books. A math workbook costs $10 and a science workbook costs $12. If you buy 12 math workbooks, what is the maximum number of science workbooks you can buy?

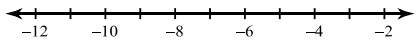
   Answer:

   a. We are given the number of math workbooks. Let s = science workbooks.
   b. 12($10) + $12s ≤ $240
   c. 120 + 12s ≤ 240
   d. 12s ≤ 120
   e. s ≤10 The school can buy 10 science workbooks.

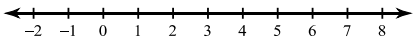
Worksheet 30.1 One-Step Inequalities

Solve each inequality and graph its solution.

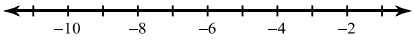
1) $-12 > x - 7$



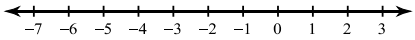
2) $-1 + r \geq 4$



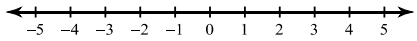
3) $n - 6 \leq -14$



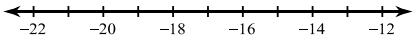
4) $b - 7 < -12$



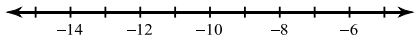
5) $a - 17 > -16$



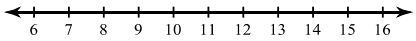
6) $15 + x \leq 0$



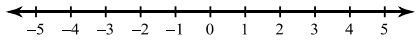
7) $3 + v \leq -9$



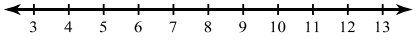
8) $8 \geq n - 6$



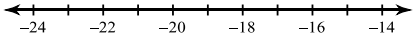
9) $-3x > 3$



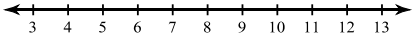
10) $\frac{n}{3} > 3$



11) $\frac{k}{4} < -4$



12) $-9x \geq -90$



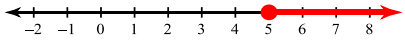
Worksheet 30.1 Answers

Solve each inequality and graph its solution.

1) $-12 > x - 7$

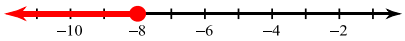
$x < -5$

2) $-1 + r \geq 4$



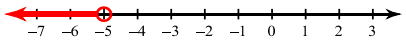
$r \geq 5$

3) $n - 6 \leq -14$



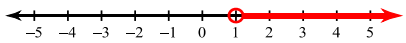
$n \leq -8$

4) $b - 7 < -12$



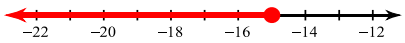
$b < -5$

5) $a - 17 > -16$



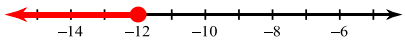
$a > 1$

6) $15 + x \leq 0$



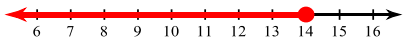
$x \leq -15$

7) $3 + v \leq -9$



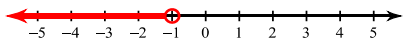
$v \leq -12$

8) $8 \geq n - 6$



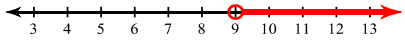
$n \leq 14$

9) $-3x > 3$



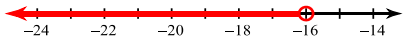
$x < -1$

10) $\frac{n}{3} > 3$



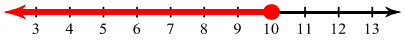
$n > 9$

11) $\frac{k}{4} < -4$



$k < -16$

12) $-9x \geq -90$

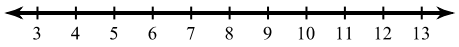


$x \leq 10$

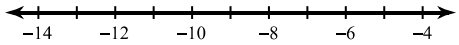
Worksheet 30.2 Two-Step Inequalities

Solve each inequality and graph its solution.

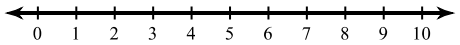
1) $2x + 4 \geq 24$



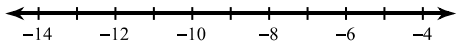
2) $\frac{m}{3} - 3 \leq -6$



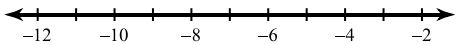
3) $-3(p + 1) \leq -18$



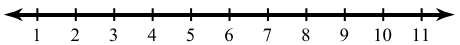
4) $-4(-4 + x) > 56$



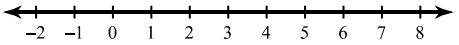
5) $-b - 2 > 8$



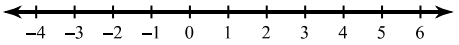
6) $-4(3 + n) > -32$



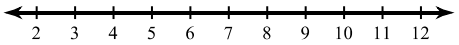
7) $4 + \frac{n}{3} < 6$



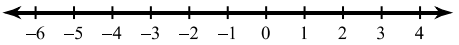
8) $-3(r - 4) \geq 0$



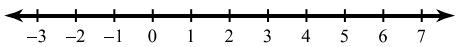
9) $-7x + 7 \leq -56$



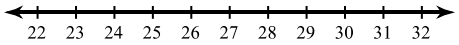
10) $-3(p - 7) \geq 21$



11) $-11x - 4 > -15$



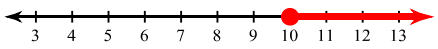
12) $\frac{-9 + a}{15} > 1$



Worksheet 30.2 Answers

Solve each inequality and graph its solution.

1) $2x + 4 \geq 24$

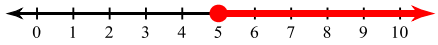


$x \geq 10$

2) $\frac{m}{3} - 3 \leq -6$

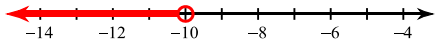
$m \leq -9$

3) $-3(p + 1) \leq -18$



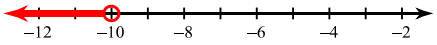
$p \geq 5$

4) $-4(-4 + x) > 56$



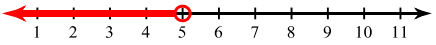
$x < -10$

5) $-b - 2 > 8$



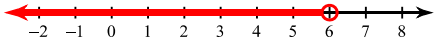
$b < -10$

6) $-4(3 + n) > -32$



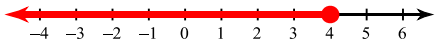
$n < 5$

7) $4 + \frac{n}{3} < 6$



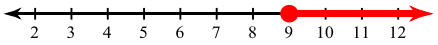
$n < 6$

8) $-3(r - 4) \geq 0$



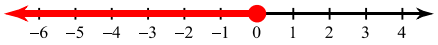
$r \leq 4$

9) $-7x + 7 \leq -56$



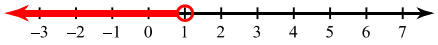
$x \geq 9$

10) $-3(p - 7) \geq 21$



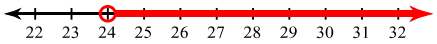
$p \leq 0$

11) $-11x - 4 > -15$



$x < 1$

12) $\frac{-9 + a}{15} > 1$



$a > 24$

Exit Ticket

Write inequalities to solve the following problems. Then, graph your solutions.

1. Pablo makes $300 a day and works 20 days a month, but he is fined $20 every day he is late. How many days can he be late if he wants to make at least $5,910?

2. A school has a budget of $240 per class to buy books. A math workbook costs $10 and a science workbook costs $12. If you buy 12 math workbooks, what is the maximum number of science workbooks you can buy?