What's the Problem with Inequalities?

Tuesdays for Teachers

April 25, 2017

Welcome!

- Daphne Atkinson, GED Testing Service
- Debi Faucette, GED Testing Service
- Bonnie Goonen, Consultant to GEDTS
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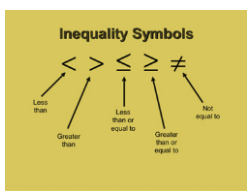
Objectives



- Discuss using High Impact Indicators to drive instruction
- Review the basics of working with inequalities
- Investigate importance of students' understanding of inequalities
- Share resources and ideas

Skill Sets for High Impact Indicators in Mathematical Reasoning

Focusing Instruction

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PLD

HII

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Descriptors for Inequalities

A.3 Write, manipulate, solve, and graph linear inequalities

- **A.3.a** Solve linear inequalities in one variable with rational number coefficients.
- **A.3.b** Identify or graph the solution to a one variable linear inequality on a number line.
- **A.3.c** Solve real-world problems involving inequalities.
- A.3.d Write linear inequalities in one variable to represent context.

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Can your students . . .

- Solve inequalities in one variable, using the standard algorithms?
- Solve a one-variable inequality and identify or create a graph on the number line of the solution?
- Analyze the relationship between quantities in a real-world problem, and then create an inequality to model the problem situation?
- Analyze the relationship between quantities in a real-world problem, and then solve the problem through algebraic reasoning?

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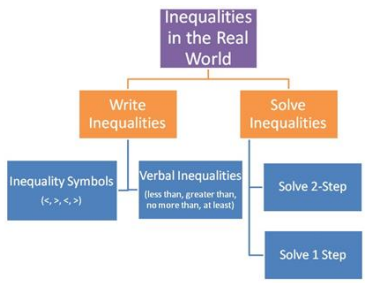
The Inequality Ladder of Fame!



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What is an inequality?

An inequality is a mathematical sentence that uses symbols such as <, ≤, >, or ≥ to compare two quantities.

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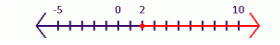
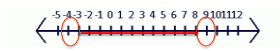
What is an inequality?

An inequality is a math statement that defines a range of values.

Jeffrey runs at least two miles every day.



On November 28, the temperature in North Pole, Alaska is expected to be greater than -4° and less than 9°



$T < 6$

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Inequalities – No Problem

Understanding and using inequalities in real-life situations

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Inequalities are Everywhere

Situation	Mathematical Inequality
Speed limit	Legal speed on the highway ≤ 65 miles per hour
Credit card	Monthly payment ≥ 10% of your balance in that billing cycle
Text messaging	Allowable number of text messages per month ≤ 250
Travel time	Time needed to drive from home to school/work ≥ 18 minutes

Recognize the Symbols

Phrase	Inequality
"a is more than b"	a > b
"a is at least b"	a ≥ b
"a is less than b"	a < b
"a is at most b;" or "a is no more than b"	a ≤ b

Inequality tells what is "allowable" or "possible." An inequality places conditions on the value of the variable.

Learn the Vocabulary

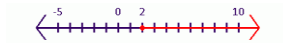
Term	Inequality
Coefficient	4a>8
Boundary Point	A solution that makes the inequality true.
Solution Set	The range of values that make the inequality true
Inclusive	a ≤ 6 
Exclusive	a < 6 

Inequality tells what is "allowable" or "possible"

Look Back at our Graphs

Remember - An inequality is a math statement that defines a range of values.

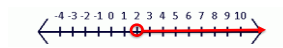
Jeffrey runs at least two miles every day.



On Nov. 28, the temperature in North Pole, Alaska is expected to be greater than -4° and less than 9°

$T < 6$

$4a > 8$



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Reading Inequalities

Have students read inequalities by starting with the variable.

Myth – When graphing an inequality on a number line the arrow always points in the same direction as the inequality sign.

$x \leq 4$

$4 \geq x$

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Rules for Solving Inequalities

1. Make the same changes to both sides of the inequality
2. Isolate the variable
3. Combine like terms
4. Use the inverse operation to remove clutter from the variable
5. If your inverse operation is multiplication or division by a negative number, reverse the inequality sign

< becomes >
> becomes <
≤ becomes ≥
≥ becomes ≤

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Properties of Inequalities

Addition and Subtraction

If a > b, then a + c > b + c

If a > b, then a - c > b – c

Real-life situation
Becky is older than Janet: b > j
Add 10 years: b + 10 > j + 10
Subtract 10 years: b – 10 > j - 10

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Properties of Inequalities

Multiplication and Division

If a > b, then ac > bc, if c > 0

If a < b, then ac < bc, if c <0

Real-life situation
Becky is older than Janet: b > j
When they are twice their current age:
b(2) > j(2)
When they were half the age they are now:
$\frac{b}{2} > \frac{j}{2}$

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But…there is one exception

When you multiply or divide each side of an inequality by a negative number, you must reverse the inequality symbol!

WHY?

Multiplying or dividing both sides of an equation by a negative number changes the sign of each side of the equation. On both sides, what was positive becomes negative, and what was negative becomes positive.

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But…there is one exception

$-3n > 12$ If you divide or multiply by a negative number

$\frac{-3n}{-3} > \frac{12}{-3}$ reverse the inequality symbol

$n < -4$

Solution: all numbers less than -4

Testing the Property

3 > 2

Multiply by -1

(-1)(3) > 2 (-1)

-3 > -2 **FALSE**

-3 < -2 **TRUE**

Multiplying by a negative flipped the inequality sign from "greater than" to "less than."

Solving Inequalities

$4 + x < 12$

$4 + \boxed{x} < 12$ (draw wall down inequality)

$4 + x < 12$ (box in variable)

$4 + x < 12$ (minus 4 both sides)

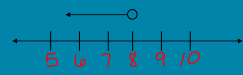
$-4 \quad -4$

$x < 8$

Graphing the solution

$x < 8$

1. Draw a number line. Just need a few numbers on either side of the solution number.



2. Decide if open circle or closed circle. Place it above the solution number.
3. Determine which way your arrow goes by substituting a number in for the variable to make the statement true. Then draw the arrow pointing in that direction.

Solve the Inequality

$48 \geq 8m$

$\frac{48}{8} \geq \frac{8m}{8}$ (draw wall, box variable)

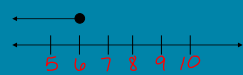
(divide 8 both sides)

$6 \geq m$

Graph the Solution

$6 \geq m$

1. Draw a number line. Just need a few numbers on either side of the solution number.

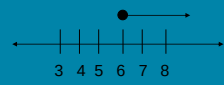


2. Decide if open circle or closed circle. Place it above the solution number.
3. Determine which way your arrow goes by substituting a number in for the variable to make the statement true. Then draw the arrow pointing in that direction.

$6u \geq 36$

$$\frac{6u}{6} \geq \frac{36}{6}$$

$$u \geq 6$$



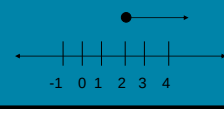
$3y - 1 \geq 5$

$$3y - 1 \geq 5$$

$$+1 \quad +1$$

$$\frac{3y}{3} \geq \frac{6}{3}$$

$$y \geq 2$$



Solving Inequalities

$5x + 7 < 3(x + 1)$

$5x + 7 < 3(x + 1)$

$5x + 7 < 3x + 3$

Since you divided by a positive number, there is no need to reverse the inequality sign.

$2x + 7 < 3$

$-7 \quad 3 - 7$

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

***x* < –2** or ***x* > –2**

Solving Inequalities

-2x < 5

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

$x < -5/2$

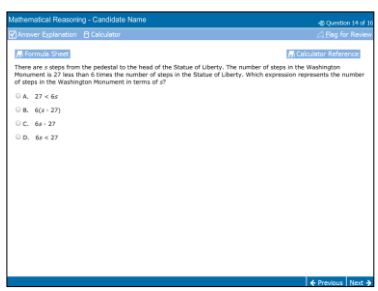
$x > -5/2$

Since you divided by a negative number, you need to reverse the inequality sign.

Solving Real-World Inequalities

It begins with translation

What would your students do?



1. Guess
2. Select "C" because they haven't used it in a while
3. Skip it
4. Sign up for a retest

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What students need to do!

1. Read the problem carefully and determine what you are trying to find
2. Assign a variable to the quantity that must be found
3. Write down what the variable represents
4. Write the inequality
5. Solve the inequality
6. Test the solution set
7. Look back at the problem

Recognize the Symbols and Words

Inequality	Commonly Known	Other Words to Know
≠	is not equal to	does not equal
≥	greater than or equal to	at least; no fewer than; a minimum of; no less than
≤	less than or equal to	at most; no more than; a maximum of; any more than
<	less than	fewer than
>	greater than	more than

An inequality places conditions on the value of the variable.

Your Turn!

Coach told us we needed to complete more than 18 repetitions.

Which one is correct?

1. N ≥ 18
2. N ≤ 18
3. N > 18
4. N < 18

Your Turn!

Children under 12 pay a discounted price at the movie theatre.

Which one is correct?

1. N ≥ 12
2. N ≤ 12
3. N > 12
4. N < 12

Your Turn!

Marie has purchased party supplies for a maximum of 12 people.

Which one is correct?

1. N ≥ 12
2. N ≤ 12
3. N > 12
4. N < 12

Start with the Basics

Jennifer has 10 fewer DVDs than Brad.

$j - 10 = b$

(common answer, but incorrect)

Insert the words and see the difference in the equation.

j (has) $= b$ (fewer) $- 10$

so

$j = b - 10$

Build Skills in Vocabulary and Translation

Translating Words into Mathematical Phrases

The sum of a number n and 5	$n + 5$
4 more than a number n	$4 + n$
13 less than a number n	$n - 13$
A number n subtracted from 5	$5 - n$
A number n increased by 8	$n + 8$
A number n decreased by 8	$n - 8$
Twice the number n	$2n$
The sum of 4 times a number n and 7	$4n + 7$
The product of n and m	nm
A number n divided by 5	$n/5$
The sum of p and q less the sum of n and m	$(p + q) - (n + m)$
9 divided by the number n	$9/n$
The quotient of n number n and 6	$n/6$
The ratio of two numbers n and m	n/m
Miles per hour	miles/hour
10% of a number n	$0.10n$
The sum of x and y is 6	$x + y = 6$
The sum of x and y is 3 more than twice the product	$x + y = 3 + 2xy$
The square of a number n	n^2
The square root of a number n	$\sqrt{n}$
The absolute value of a number n	$\lvert n \rvert$
The absolute value of the difference between x and y	$\lvert x - y \rvert$

Math Translation Guide

The chart below gives you some of the terms that come up in a lot of word problems. Use them in order to translate or "set-up" word problems into equations.

English	Math	Example	Translation
What, a number	x, n, etc.	Three more than a number is 8.	$n + 3 = 8$
Equivalent, equals, is, was, has, costs	=	Danny is 16 years old. A CD **costs** 15 dollars.	$d = 16$ $c = 15$
Is greater than Is less than At least, minimum At most, maximum	$>$ $<$ $\geq$ $\leq$	Jenny **has more** money than Ben. Ashley's age **is less than** Nick's. There are **at least** 30 questions on the test. Sam can invite **a maximum** of 15 people to his party.	$j > b$ $a < n$ $t \geq 30$ $s \leq 15$
More, more than, greater, than, added to, total, sum, increased by, together	+	Kecia has 2 **more** video games than John. Kecia and John have **a total of** 11 video games.	$k = j + 2$ $k + j = 11$
Less than, smaller than, decreased by, difference, fewer	−	Jason has 3 **fewer** CDs than Carson. **The difference between** Jenny's and Ben's savings is $75.	$j = c - 3$ $j - b = 75$
Of, times, product of, twice, double, triple, half of, quarter of	x	Emma has **twice** as many books as Justin. Justin has **half** as many books as Emma.	$e = 2 x j$ or $e = 2j$ $j = c \times ¼$ or $j = e/2$
Divided by, per, for, out of, ratio of ___ to ___	÷	Sophia has $1 for every $2 Daniel has. **The ratio of** Daniel's savings to Sophia's savings is 2 to 1.	$s = d \div 2$ or $s = d/2$ $d/s = 2/1$

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Start with Basic Translation

If *s* represents the number of books that Sam has, and *g* represents the number of books that Gerard has, which inequality models the situation "Sam has more than twice the number of books as Gerard?"

A) g < 2s

(Gerard has < twice the number of books as Sam)

B) *g > 2s*

(Gerard has > than twice the number of books as Sam)

C) *s < 2g*

(Sam has less than twice books as Gerard)

D) *s > 2g*

(Twice Gerard's books is 2 g, s has >)

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Your Turn!

Keith has $500 in a savings account at the beginning of the summer. He wants to have at least $200 in the account by the end of the summer. He uses $25 each week for food, clothes, and fun. How many weeks can Keith withdraw money from his account?

Which is correct?

1. $500 - 25w \leq 200$
2. $500 - 25w \geq 200$
3. $500 - 25w > 200$
4. $500 - 25w < 200$

At first glance, you might think that it is supposed to be less than, but Keith wants the amount in the account to be "at least" 200, which means 200 or greater. Thus, you must use ≥.

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Your Turn!

Yellow Cab Taxi charges a $1.75 flat rate in addition to $0.66 per mile. Katie has no more than $10 spend on a ride How many miles can Katie travel without exceeding her limit?

Which is correct?

1. .66x + 1.75 > 10
2. .66x + 1.75 < 10
3. .66x + 1.75 ≤ 10
4. .66x + 1.75 ≥ 10

The "no more than" can be tricky. It can make you think of "greater than" however, it really means that Katie has to spend $10.00 or less.

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Real-World Context

A new music downloading software, GotTunes, is trying to compete with iTunes. Though iTunes charges no monthly fee to download music, it charges $1.25 a song. GotTunes charges a monthly fee of $30, but a member is free to download music all month. Write an inequality and solve for how many songs you have to download to make GotTunes a better deal than iTunes.

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Write, Solve and Graph

A new music downloading software, GotTunes, is trying to compete with iTunes. Though iTunes charges no monthly fee to download music, it charges $1.25 a song. GotTunes charges a monthly fee of $30, but a member is free to download music all month. Write an inequality and solve for how many songs you have to download to make GotTunes a better deal than iTunes.

What is your unknown?

The number of songs downloaded on iTunes at $1.25 per song? 1.25x

What is the minimum number of songs you would need to download from iTunes to exceed $30 (the monthly fee)

$1.25x > 30$

$\frac{1.25}{1.25} > \frac{30}{1.25}$ (divide both sides by 1.25)

$x > 24$

You would need to download more than 24 songs a month for GotTunes to be a better deal.

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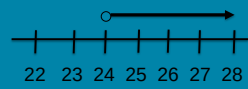
Graph the Solution

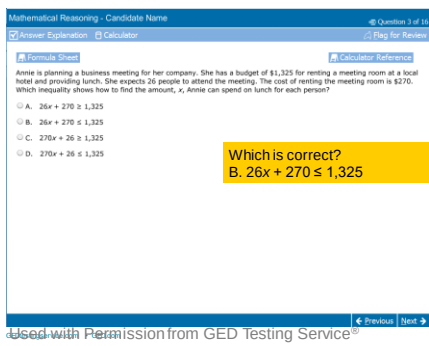
$x > 24$

1. Draw a number line. Just need a few numbers on either side of the solution number.



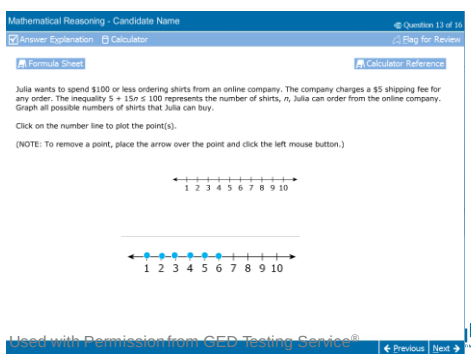
2. Decide if open circle or closed circle. Place it above the solution number.
3. Determine which way your arrow goes by substituting a number in for the variable to make the statement true. Then draw the arrow pointing in that direction.

Sample Question from GEDTS



Which is correct?
B. $26x + 270 \leq 1{,}325$

Sample Question from GEDTS



Remember, students need to

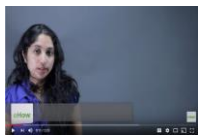
- Solve inequalities in one variable
- Solve an inequality and identify or create a graph on a number line
- Analyze relationship between quantities in real-world problem and create an inequality
- Analyze relationship between quantities in real-world problem solve the inequality

Practice – Practice – Practice

Resources for the Classroom

Online resources that everyone can use

Resources – Beginning Looks



How to Graph Inequalities for Middle School: Fractions & Other Math Tips

https://www.youtube.com/watch?v=PTDN-ApjzsM

How to Solve Inequalities

https://www.youtube.com/watch?v=wYEYeFGxHkI&t=57s

Resources

One-Variable Inequalities – Khan Academy

https://www.khanacademy.org/math/algebra/one-variable-linear-inequalities

Virtual Nerds: What is an Inequality?

https://www.youtube.com/watch?v=wcBwdz-ZBaM

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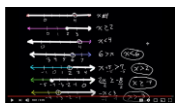
Resources

Math is Fun – Solving Inequalities

http://www.mathsisfun.com/algebra/inequality-solving.html



Very Basics of Graphing Inequalities (on a number line)

https://www.youtube.com/watch?v=nif2PKA9bXA

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Resources

Solving and Graphing Inequalities (Excellent!)

- https://www.youtube.com/watch?v=EE2qWIyjKD0

Math Dude Unit 1-4 –Solving Inequalities

https://www.youtube.com/watch?v=8hhewFQ_K0w

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Lesson Plan

Solving Linear Inequalities – Event Planning

www.floridaipdae.org/index.cfm?fuseaction=resources.GEDAHS&cagiid=35103C444218 14CCDCF2BF60B532270EE 0718F330D6DCACE4E33EF A989573B6E6

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Lesson Plan

Florida IPDAE – GED and AHS Lessons

Beginning Algebra – Lessons 14-15

http://www.floridaipdae.org/index.cfm?fuseaction=resources.GEDAHS&cagiid=DA077C783C76A85D93EE670F44851D4C70E44B31245B6D1B60A314A7FABD6FAE

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Lesson Plan

Inequalities in the Real-World

https://betterlesson.com/lesson/592219/inequalities-in-the-real-world

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Lesson Plan

Inequalities – Solving and Graphing

http://alex.state.al.us/lesson_view.php?id=29038

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Number Line Maker

Graph Inequality on Number Line

- http://www.mathwarehouse.com/number-lines/graph-inequality-on-number-line.php

Number Line Maker

- http://www.mathwarehouse.com/number-lines/number-line-maker.php
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One More!

Cool Math – Inequalities

http://www.coolmath.com/algebra/07-solving-inequalities

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Tips for Teaching Inequalities

- Make it meaningful - start with concrete examples and real-world problems
- Make your thinking processes visible
- Solve the problems different ways
- Show the application
- Provide time for discussion

TOGETHER WE TRANSFORM

July 25 – 28, 2017 • Renaissance Dallas Hotel in Dallas, Texas

Schedule

July 26, 2017 President's Reception 6:00 p.m.

Main Conference - July 26-28
Sessions for Educators
Professional Development Sessions for Adult Educators
Train the Trainer Cohort 1 - Enrichment for 2016 cohort
Best Practices in Professional Development Strategy
Reasoning Through Language Arts - Teaching and Content Strategy
Mathematics - Teaching and Content Strategy
Science - Teaching and Content Strategy
Social Studies - Teaching and Content Strategy
Classroom Teaching Strategies that Work
Using Teaching Tools and Resources
Intergenerational Strategies for the Classroom
Teaching Students How to Learn
Sessions for All Audiences
Test-Taker Insights - test-taker research highlights and how to apply the findings
WIOA - progress on implementing and preparing for WIOA benchmarks
Engagement via the GEDWorks™ Program
Post Secondary Education Outcomes and Activities
GED College Ready and GED College Ready + Credit Updates
Marketing - how to grow your program
Best Practices in Corrections Education and Testing
GEDPrep Connect™ - connecting more students to local adult ed centers

Tuesdays for Teachers

Next Tuesdays for Teachers – June 27th

- More content-based information
- More strategies and activities
- More resources

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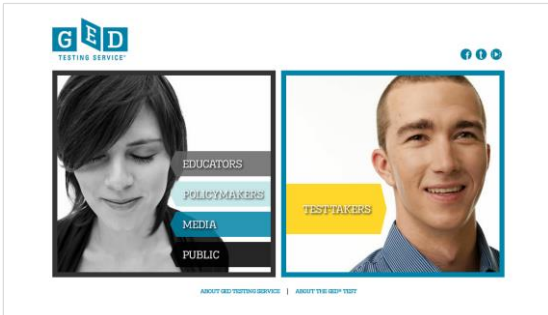

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Thank you!