CCGPS Frameworks Student Edition

Mathematics

Accelerated CCGPS Coordinate Algebra / Analytic Geometry A
Unit 2: Reasoning with Equations and Inequalities

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"Making Education Work for All Georgians"

Unit 2
Reasoning with Equations and Inequalities

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OVERVIEW

In this unit students will:

- solve linear equations in one variable.
- solve linear inequalities in one variable.
- solve a system of two equations in two variables by using multiplication and addition.
- solve a system of two equations in two variables graphically
- graph a linear inequality in two variables.
- graph a system of two linear inequalities in two variables.

By the end of eighth grade, students have learned to solve linear equations in one variable and have applied graphical and algebraic methods to analyze and solve systems of linear equations in two variables. The second unit expands the previously learned concepts of solving and graphing linear equations and inequalities, focusing on the reasoning and understanding involved in justifying the solution. Students are asked to explain and justify the mathematics required to solve both simple equations and systems of equations in two variables using both graphing and algebraic methods. Students explore systems of equations and inequalities, and they find and interpret their solutions. Students develop fluency writing, interpreting, and translating between various forms of linear equations and inequalities, and using them to solve problems. They master the solution of linear equations and apply related solution techniques and the laws of exponents to the creation and solution of simple exponential equations. All of this work is grounded on understanding quantities and on relationships between them.

Although the units in this instructional framework emphasize key standards and big ideas at specific times of the year, routine topics such as estimation, mental computation, and basic computation facts should be addressed on an ongoing basis. Ideas related to the eight practice standards should be addressed constantly as well. To assure that this unit is taught with the appropriate emphasis, depth, and rigor, it is important that the tasks listed under "Evidence of Learning" be reviewed early in the planning process. A variety of resources should be utilized to supplement this unit. This unit provides much needed content information, but excellent learning activities as well. The tasks in this unit illustrate the types of learning activities that should be utilized from a variety of sources.

STANDARDS ADDRESSED IN THIS UNIT

KEY STANDARDS

Understand solving equations as a process of reasoning and explain the reasoning

MCC9-12.A.REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

Solve equations and inequalities in one variable

MCC9-12.A.REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Solve systems of equations

MCC9-12.A.REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

MCC9-12.A.REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically

MCC9-12.A.REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Standards for Mathematical Practice

The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education. The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections. The second are the strands of mathematical proficiency specified in the National Research Council's report *Adding It Up*: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see

mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy).

1. **Make sense of problems and persevere in solving them.** High school students start to examine problems by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. By high school, students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. They check their answers to problems using different methods and continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

2. **Reason abstractly and quantitatively.** High school students seek to make sense of quantities and their relationships in problem situations. They abstract a given situation and represent it symbolically, manipulate the representing symbols, and pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Students use quantitative reasoning to create coherent representations of the problem at hand; consider the units involved; attend to the meaning of quantities, not just how to compute them; and know and flexibly use different properties of operations and objects.

3. **Construct viable arguments and critique the reasoning of others.** High school students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. High school students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. High school students learn to determine domains to which an argument applies, listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

4. **Model with mathematics.** High school students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. High school students making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

5. **Use appropriate tools strategically.** High school students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. High school students should be sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. They are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

6. **Attend to precision.** High school students try to communicate precisely to others by using clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

7. **Look for and make use of structure.** By high school, students look closely to discern a pattern or structure. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 – 3(x – y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real

numbers x and y. High school students use these patterns to create equivalent expressions, factor and solve equations, and compose functions, and transform figures.

8. **Look for and express regularity in repeated reasoning.** High school students notice if calculations are repeated, and look both for general methods and for shortcuts. Noticing the regularity in the way terms cancel when expanding $(x – 1)(x + 1)$, $(x – 1)(x^2 + x + 1)$, and $(x – 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, derive formulas or make generalizations, high school students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.

Connecting the Standards for Mathematical Practice to the Standards for Mathematical Content

The Standards for Mathematical Practice describe ways in which developing student practitioners of the discipline of mathematics should engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle and high school years. Designers of curricula, assessments, and professional development should all attend to the need to connect the mathematical practices to mathematical content in mathematics instruction.

The Standards for Mathematical Content are a balanced combination of procedure and understanding. Expectations that begin with the word “understand” are often especially good opportunities to connect the practices to the content. Students who do not have an understanding of a topic may rely on procedures too heavily. Without a flexible base from which to work, they may be less likely to consider analogous problems, represent problems coherently, justify conclusions, apply the mathematics to practical situations, use technology mindfully to work with the mathematics, explain the mathematics accurately to other students, step back for an overview, or deviate from a known procedure to find a shortcut. In short, a missing mathematical knowledge effectively prevents a student from engaging in the mathematical practices.

In this respect, those content standards which set an expectation of understanding are potential “points of intersection” between the Standards for Mathematical Content and the Standards for Mathematical Practice. These points of intersection are intended to be weighted toward central and generative concepts in the school mathematics curriculum that most merit the time, resources, innovative energies, and focus necessary to qualitatively improve the curriculum, instruction, assessment, professional development, and student achievement in mathematics.

ENDURING UNDERSTANDINGS

- Solve linear equations and inequalities is one variable.
- Graph linear equations and inequalities in two variables.
- Solve systems of linear equations in two variables exactly and approximately.

- Create linear equations and inequalities in one variable and use them in a contextual situation to solve problems.
- Create equations in two or more variables to represent relationships between quantities.
- Graph equations in two variables on a coordinate plane and label the axes and scales.
- Write and use a system of equations and/or inequalities to solve real world problems.

CONCEPTS/SKILLS TO MAINTAIN

Students may not realize the importance of unit conversion in conjunction with computation when solving problems involving measurement. Since today's calculating devices often display 8 to 10 decimal places, students frequently express answers to a much greater degree of precision than is required.

Measuring commonly used objects and choosing proper units for measurement are part of the mathematics curriculum prior to high school. In high school, students experience a broader variety of units through real-world situations and modeling, along with the exploration of the different levels of accuracy and precision of the answers.

An introduction to the use of variable expressions and their meaning, as well as the use of variables and expressions in real-life situations, is included in the Expressions and Equations Domain of Grade 7.

Working with expressions and equations, including formulas, is an integral part of the curriculum in Grades 7 and 8. In high school, students explore in more depth the use of equations and inequalities to model real-world problems, including restricting domains and ranges to fit the problem's context, as well as rewriting formulas for a variable of interest.

It is expected that students will have prior knowledge/experience related to the concepts and skills identified below. It may be necessary to pre-assess to determine whether instructional time should be spent on conceptual activities that help students develop a deeper understanding of these ideas.

- Using the Pythagorean Theorem
- Understanding slope as a rate of change of one quantity in relation to another quantity
- Interpreting a graph
- Creating a table of values
- Working with functions
- Writing a linear equation
- Using inverse operations to isolate variables and solve equations
- Maintaining order of operations
- Understanding notation for inequalities
- Being able to read and write inequality symbols

- Graphing equations and inequalities on the coordinate plane
- Understanding and use properties of exponents
- Graphing points
- Choosing appropriate scales and label a graph

SELECTED TERMS AND SYMBOLS

The following terms and symbols are often misunderstood. These concepts are not an inclusive list and should not be taught in isolation. However, due to evidence of frequent difficulty and misunderstanding associated with these concepts, instructors should pay particular attention to them and how their students are able to explain and apply them.

The definitions below are for teacher reference only and are not to be memorized by the students. Students should explore these concepts using models and real life examples. Students should understand the concepts involved and be able to recognize and/or demonstrate them with words, models, pictures, or numbers.

The websites below are interactive and include a math glossary suitable for high school children. **Note – At the high school level, different sources use different definitions. Please preview any website for alignment to the definitions given in the frameworks.**

http://www.amathsdictionaryforkids.com/
This web site has activities to help students more fully understand and retain new vocabulary.

http://intermath.coe.uga.edu/dictnary/homepg.asp
Definitions and activities for these and other terms can be found on the Intermath website. Intermath is geared towards middle and high school students.

- **Algebra:** The branch of mathematics that deals with relationships between numbers, utilizing letters and other symbols to represent specific sets of numbers, or to describe a pattern of relationships between numbers.

- **Coefficient:** A number multiplied by a variable.

- **Equation:** A number sentence that contains an equals symbol.

- **Expression:** A mathematical phrase involving at least one variable and sometimes numbers and operation symbols.

- **Inequality**: Any mathematical sentence that contains the symbols > (greater than), < (less than), $\leq$ (less than or equal to), or $\geq$ (greater than or equal to).

- **Ordered Pair**: A pair of numbers, (x, y), that indicate the position of a point on a Cartesian plane.

- **Substitution:** To replace one element of a mathematical equation or expression with another.

- **Variable:** A letter or symbol used to represent a number.

The Properties of Operations

Here *a*, *b* and *c* stand for arbitrary numbers in a given number system. The properties of operations apply to the rational number system, the real number system, and the complex number system.

Associative property of addition	$(a + b) + c = a + (b + c)$
Commutative property of addition	$a + b = b + a$
Additive identity property of 0	$a + 0 = 0 + a = a$
Existence of additive inverses	For every a there exists $-a$ so that $a + (-a) = (-a) + a = 0$.
Associative property of multiplication	$(a \times b) \times c = a \times (b \times c)$
Commutative property of multiplication	$a \times b = b \times a$
Multiplicative identity property of 1	$a \times 1 = 1 \times a = a$
Existence of multiplicative inverses	For every $a \neq 0$ there exists $1/a$ so that $a \times 1/a = 1/a \times a = 1$.
Distributive property of multiplication over addition	$a \times (b + c) = a \times b + a \times c$

The Properties of Equality

Here *a*, *b* and *c* stand for arbitrary numbers in the rational, real, or complex number systems.

Reflexive property of equality	$a = a$
Symmetric property of equality	If $a = b$, then $b = a$.
Transitive property of equality	If $a = b$ and $b = c$, then $a = c$.
Addition property of equality	If $a = b$, then $a + c = b + c$.
Subtraction property of equality	If $a = b$, then $a - c = b - c$.
Multiplication property of equality	If $a = b$, then $a \times c = b \times c$.
Division property of equality	If $a = b$ and $c \neq 0$, then $a \div c = b \div c$.
Substitution property of equality	If $a = b$, then b may be substituted for a in any expression containing a.

Jaden's Phone Plan

Mathematical Goals

- Create one-variable linear equations and inequalities from contextual situations.
- Solve and interpret the solution to multi-step linear equations and inequalities in context.

Common Core State Standards

MCC9-12.A.REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

MCC9-12.A.REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.

Jaden has a prepaid phone plan (Plan *A*) that charges 15 cents for each text sent and 10 cents per minute for calls.

1. If Jaden uses only text, write an equation for the cost C of sending t texts.

   a. How much will it cost Jaden to send 15 texts? Justify your answer.

   b. If Jaden has \$6, how many texts can he send? Justify your answer.

2. If Jaden only uses the talking features of his plan, write an equation for the cost C of talking m minutes.

   a. How much will it cost Jaden to talk for 15 minutes? Justify your answer.

b. If Jaden has $6, how many minutes can he talk? Justify your answer.

3. If Jaden uses both talk and text, write an equation for the cost *C* of sending t texts and talking *m* minutes.

a. How much will it cost Jaden to send 7 texts and talk for 12 minutes? Justify your answer.

b. If Jaden wants to send 21 texts and only has $6, how many minutes can he talk? Will this use all of his money? If not, will how much money will he have left? Justify your answer.

Jaden discovers another prepaid phone plan (Plan *B*) that charges a flat fee of $15 per month, then $.05 per text sent or minute used.

4. Write an equation for the cost of Plan *B*.

In an average month, Jaden sends 200 texts and talks for 100 minutes.

5. Which plan will cost Jaden the least amount of money? Justify your answer.

Solving System of Equations Algebraically

Mathematical Goals

- Model and write an equation in one variable and solve a problem in context.
- Create one-variable linear equations and inequalities from contextual situations.
- Represent constraints with inequalities.
- Solve word problems where quantities are given in different units that must be converted to understand the problem.

Common Core State Standards

MCC9-12.A.REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

MCC9-12.A.REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

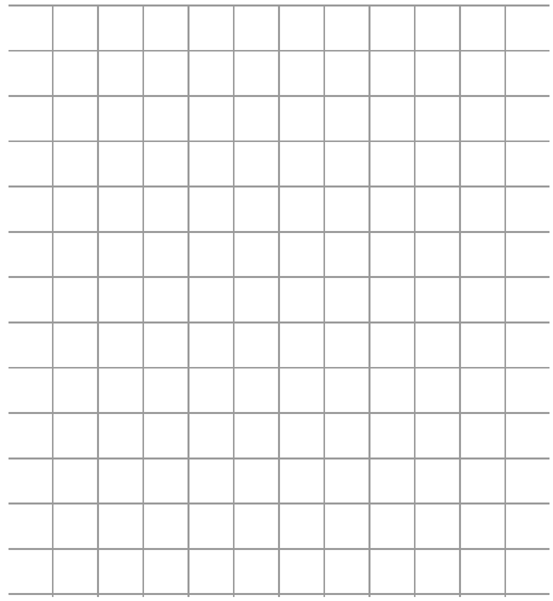
Standards for Mathematical Practice
1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.

Part 1:

You are given the following system of two equations: $x + 2y = 16$
$3x – 4y = –2$

1. What are some ways to prove that the ordered pair (6, 5) is a solution?

a. Prove that (6, 5) is a solution to the system by graphing the system.



b. Prove that (6, 5) is a solution to the system by substituting in for both equations.

2. Multiply both sides of the equation $\boldsymbol{x + 2y = 16}$ by the constant '7'. Show your work.

$\mathbf{7}*(x + 2y) = \mathbf{7}*16$

________________ New Equation

a. Does the new equation still have a solution of (6, 5)? Justify your answer.

b. Why do you think the solution to the equation never changed when you multiplied by the '7'?

3. Did it have to be a '7' that we multiplied by in order for (6, 5) to be a solution?

   a. Multiply $\boldsymbol{x + 2y = 16}$ by three other numbers and see if (6, 5) is still a solution.

      i. ________________________

      ii. ________________________

      iii. ________________________

   b. Did it have to be the first equation $\boldsymbol{x + 2y = 16}$ that we multiplied by the constant for (6, 5) to be a solution? Multiply $\boldsymbol{3x – 4y = –2}$ by '7'? Is (6, 5) still a solution?

   c. Multiply $\boldsymbol{3x – 4y = –2}$ by three other number and see if (6, 5) is still a solution.

      i. ________________________

      ii. ________________________

      iii. ________________________

4. Summarize your findings from this activity so far. Consider the following questions:
   What is the solution to a system of equations and how can you prove it is the solution?
   Does the solution change when you multiply one of the equations by a constant?
   Does the value of the constant you multiply by matter?
   Does it matter which equation you multiply by the constant?

Let's explore further with a new system. $5x + 6y = 9$
$4x + 3y = 0$

5. Show by substituting in the values that (-3, 4) is the solution to the system.

6. Multiply $\mathbf{4x + 3y = 0}$ by '-5'. Then add your answer to $\mathbf{5x + 6y = 9}$. Show your work below.

$(–5)*(4x + 3y) = (–5)*0$ → ____________________ Answer

\+ _____$5x + 6y = 9$______

_____________________ New Equation

7. Is (–3, 4) still a solution to the new equation? Justify your answer.

8. Now multiply $4x + 3y = 0$ by '–2'. Then add your answer to $\mathbf{5x + 6y = 9}$. Show your work below.

   a. What happened to the *y* variable in the new equation?

b. Can you solve the new equation for x? What is the value of x? Does this answer agree with the original solution?

c. How could you use the value of x to find the value of y from one of the original equations? Show your work below.

The method you have just used is called the Elimination Method for solving a system of equations. When using the Elimination Method, one of the original variables is eliminated from the system by adding the two equations together. Use the Elimination Method to solve the following system of equations:

9. $-3x + 2y = -6$
$5x - 2y = 18$

10. $-5x + 7y = 11$
$5x + 3y = 19$

Solving System of Equations Algebraically

Part 2:

When using the Elimination Method, one of the original variables is eliminated from the system by adding the two equations together. Sometimes it is necessary to multiply one or both of the original equations by a constant. The equations are then added together and one of the variables is eliminated. Use the Elimination Method to solve the following system of equations:

1. $4x + 3y = 14$ (Equation 1)
   $-2x + y = 8$ (Equation 2)

Choose the variable you want to eliminate.

a. To make the choice, look at the coefficients of the x terms and the y terms. The coefficients of x are '4' and '–2'. If you want to eliminate the x variable, you should multiply Equation 2 by what constant?

   i. Multiply Equation 2 by this constant. Then add your answer equation to Equation 1. What happened to the x variable?

   ii. Solve the equation for y. What value did you get for y?

   iii. Now substitute this value for y in Equation 1 and solve for x. What is your ordered pair solution for the system?

iv. Substitute your solution into Equation 1 and Equation 2 to verify that it is the solution for the system.

b. The coefficients of y are '3' and '1'. If you want to eliminate the y term, you should multiply Equation 2 by what constant?

i. Multiply Equation 2 by this constant. Then add your answer equation to Equation 1. What happened to the y variable?

ii. Solve the equation for x. What value did you get for x?

iii. Now substitute this value for x in Equation 1 and solve for y. What is your ordered pair solution for the system?

Use your findings to answer the following in sentence form:

c. Is the ordered pair solution the same for either variable that is eliminated? Justify your answer.

d. Would you need to eliminate both variables to solve the problem? Justify your answer.

e. What are some things you should consider when deciding which variable to eliminate? Is there a wrong variable to eliminate?

f. How do you decide what constant to multiply by in order to make the chosen variable eliminate?

Use the elimination method to solve the following systems of equations. Verify your solution by substituting it into the original system.

2. $3x + 2y = 6$
   $-6x - 3y = -6$

3. $-6x + 5y = 4$
   $7x - 10y = -8$

4. $5x + 6y = -16$
   $2x + 10y = 5$

Summer Job

Mathematical Goals

- Model and write an inequality in two variables and solve a problem in context.
- Create two-variable linear equations and inequalities from contextual situations.
- Solve word problems involving inequalities.
- Represent constraints with inequalities.

Common Core State Standards

MCC9-12.A.REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.

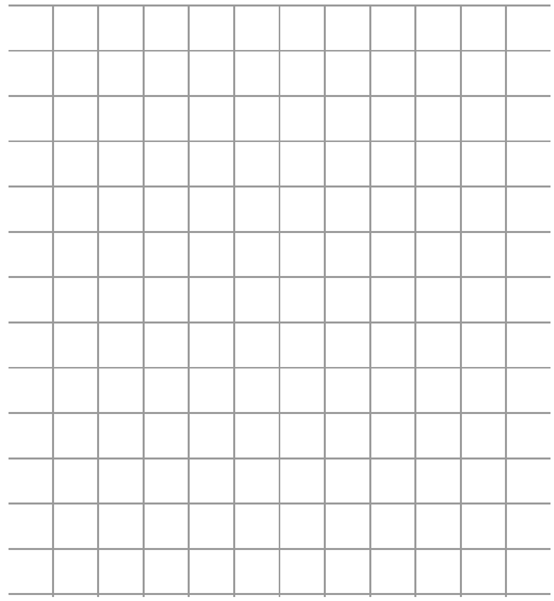
In order to raise money, you are planning to work during the summer babysitting and cleaning houses. You earn \$10 per hour while babysitting and \$20 per hour while cleaning houses. You need to earn at least \$1000 during the summer.

1. Write an expression to represent the amount of money earned while babysitting. Be sure to choose a variable to represent the number of hours spent babysitting.

2. Write an expression to represent the amount of money earned while cleaning houses.

3. Write a mathematical model (inequality) representing the total amount of money earned over the summer from babysitting and cleaning houses.

4. Graph the mathematical model. Graph the hours babysitting on the *x*-axis and the hours cleaning houses on the *y*-axis.



5. Use the graph to answer the following:

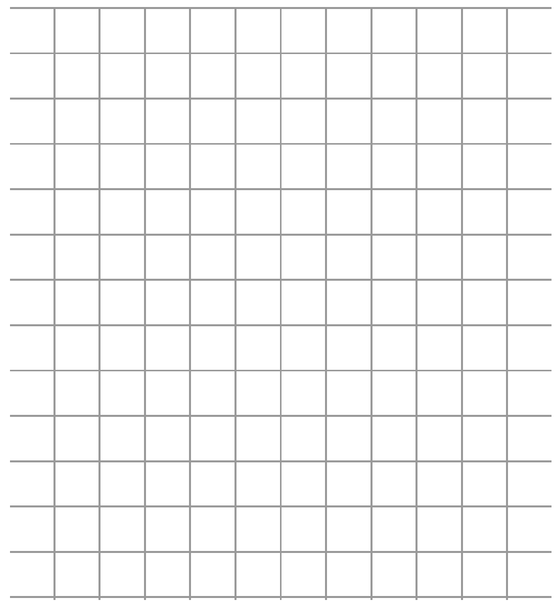
   a. Why does the graph only fall in the 1st Quadrant?

   b. Is it acceptable to earn exactly \$1000? What are some possible combinations of outcomes that equal exactly \$1000? Where do all of the outcomes that total \$1000 lie on the graph?

   c. Is it acceptable to earn more than \$1000? What are some possible combinations of outcomes that total more than \$1000? Where do all of these outcomes fall on the graph?

   d. Is it acceptable to work 10 hours babysitting and 10 hours cleaning houses? Why or why not? Where does the combination of 10 hours babysitting and 10 hours cleaning houses fall on the graph? Are combinations that fall in this area a solution to the mathematical model? Why or why not?

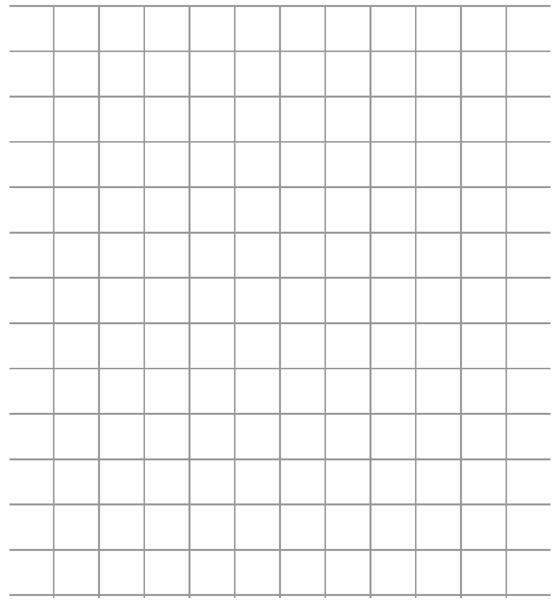
6. How would the model change if you could only earn more than $1000? Write a new model to represent needing to earn more than $1000. How would this change the graph of the model? Would the line still be part of the solution? How would you change the line to show this? Graph the new model.



You plan to use part of the money you earned from your summer job to buy jeans and shirts for school. Jeans cost $40 per pair and shirts are $20 each. You want to spend less than $400 of your money on these items.

7. Write a mathematical model representing the amount of money spent on jeans and shirts.

8. Graph the mathematical model. Graph the number of jeans on the *x*-axis and shirts on the *y*-axis.



   a. Why does the graph only fall in the 1st Quadrant?

   b. Is it acceptable to spend less than \$400? What are some possible combinations of outcomes that total less than \$400? Where do all of these outcomes fall on the graph?

   c. Is it acceptable to spend exactly \$400? How does the graph show this?

   d. Is it acceptable to spend more than \$400? Where do all of the combinations that total more than \$400 fall on the graph?

Summarize your knowledge of graphing inequalities in two variables by answering the following questions in sentence form:

9. Explain the difference between a solid line and a broken line when graphing inequalities. How can you determine from the model whether the line will be solid or broken? How can you look at the graph and know if the line is part of the solution?

10. How do you determine which area of the graph of an inequality to shade? What is special about the shaded area of an inequality? What is special about the area that is not shaded?

<u>Graphing Inequalities</u>

Mathematical Goals

- Model and write an inequality in two variables and solve a problem in context.
- Create two-variable linear equations and inequalities from contextual situations.
- Solve word problems involving inequalities.
- Represent constraints with inequalities.

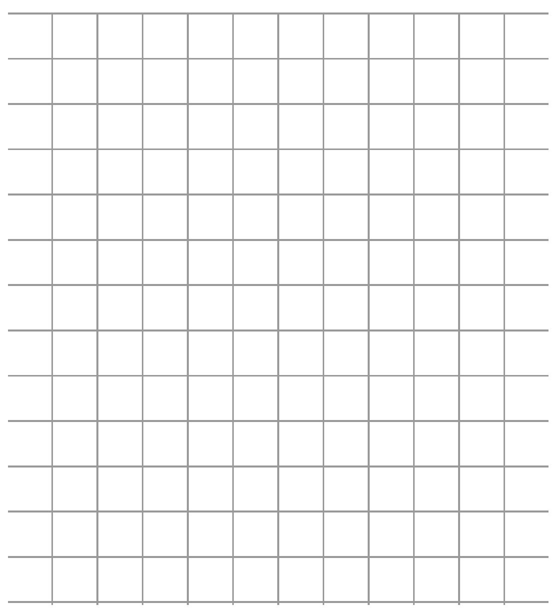
Common Core State Standards

MCC9-12.A.REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

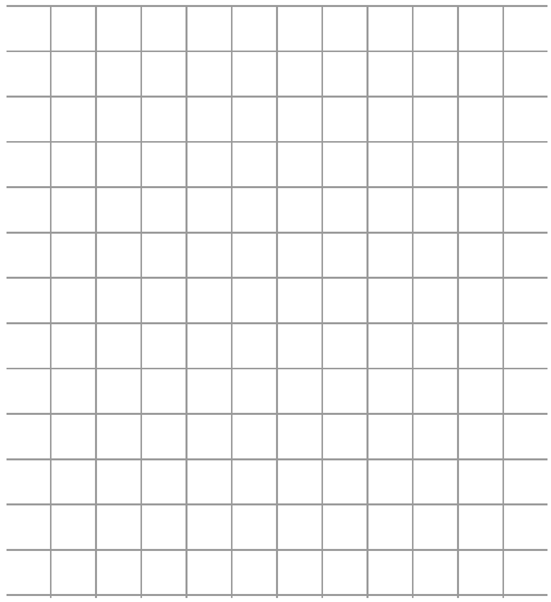
Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.

1. Graph the inequality $y > -\frac{1}{2}x + 5$. What are some solutions to the inequality?



2. Graph the inequality $y < x + 2$. What are some solutions to the inequality?

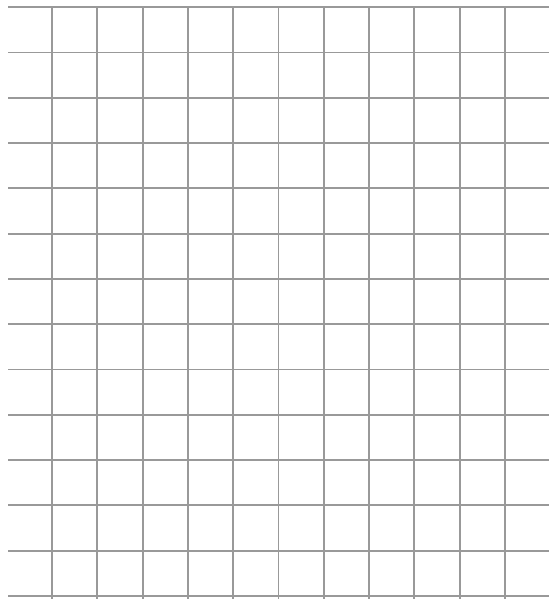


3. Look at both graphs.

   a. Are there any solutions that work for both inequalities? Give 3 examples.

   b. Are there any solutions that work for 1 inequality but not the other? Give 3 examples and show which inequality it works for.

4. Graph both inequalities on the same coordinate system, using a different color to shade each.



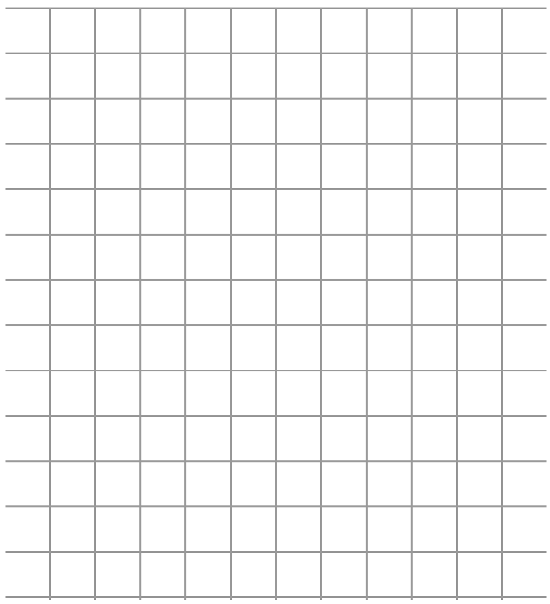
   a. Look at the region that is shaded in both colors. What does this region represent?

   b. Look at the regions that are shaded in only 1 color. What do these regions represent?

   c. Look at the region that is not shaded. What does this region represent?

5. Graph the following system on the same coordinate grid. Use different colors for each.

$$x + y \geq 3$$
$$y \leq -x + 5$$



a. Give 3 coordinates that are solutions to the system.

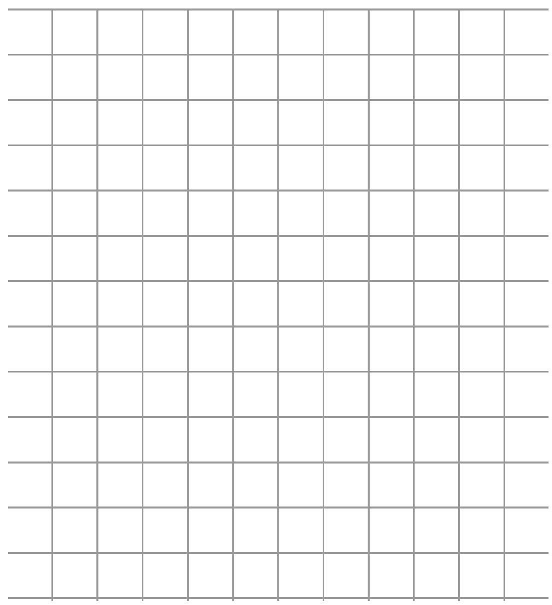
b. Give 3 coordinates that are not solutions to the system.

c. Is a coordinate on either line a solution?

d. How would you change the inequality $x + y \geq 3$ so that it would shade below the line?

e. How would you change the inequality $y \leq -x + 5$ so that it would shade above the line?

6. Graph the new equations from ‘d’ and ‘e’ above on the same coordinate grid. Use blue for one graph and red for the other.



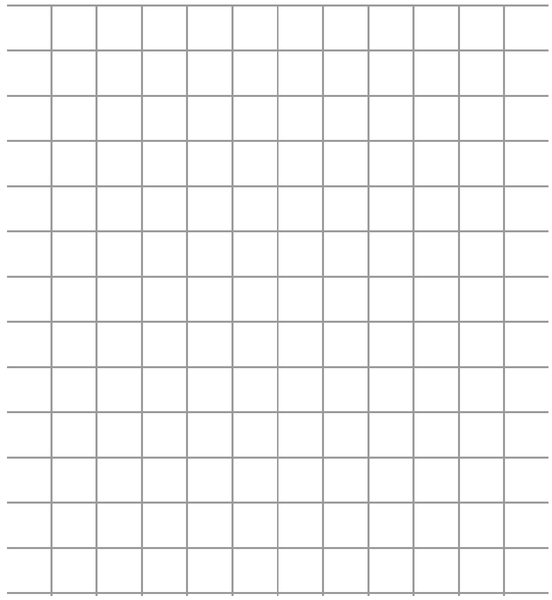
a. What do the coordinates in blue represent?

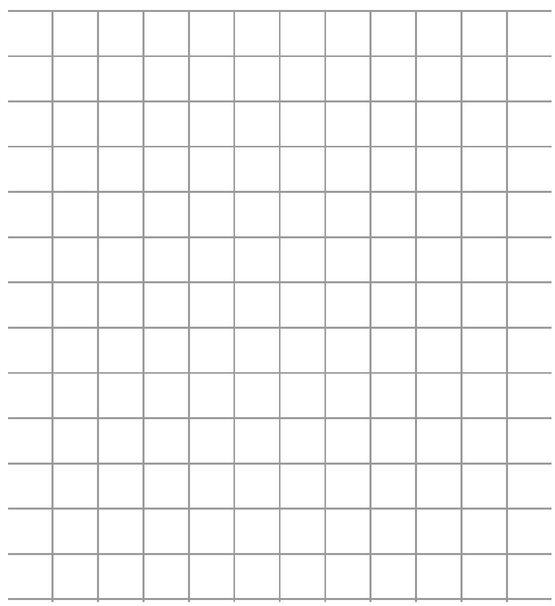
b. What do the coordinates in red represent?

c. Why do the colors not overlap this time?

Graph the following on the same coordinate grid and give 3 solutions for each.

7. $2x + 3y < 6$
   $x + 5y > 5$





8. $y \geq \frac{1}{2} x - 1$

   $y \leq -\frac{1}{4} x + 6$

9. $3x - 4y > 5$

   $y > \frac{3}{4}x + 1$