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NINTH YEAR MATHEMATICS. COURSE I, ALGEBRA.

NEW YORK STATE EDUCATION DEPT., ALBANY

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THIS GUIDE OUTLINES THE MINIMUM MATERIAL FOR WHICH STUDENTS OF NINTH YEAR MATHEMATICS - COURSE 1 - ALGEBRA WERE HELD RESPONSIBLE ON THE REGENTS EXAMINATIONS BEGINNING IN JUNE, 1966. THE REPORT ALSO PRESENTS THE SCOPE AND CONTENT OF THE ALGEBRA COURSE AND POSSIBLE SUGGESTIONS FOR TEACHING THE MATERIAL TO STUDENTS. (RP)

NINTH YEAR

Mathematics

COURSE 1-ALGEBRA

THE UNIVERSITY OF THE STATE OF NEW YORK/ THE STATE EDUCATION DEPARTMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT/ ALBANY/ 1965

NINTH YEAR MATHEMATICS

Course I - ALGEBRA

1965 Revision

The University of the State of New York
New York State Education Department
Bureau of Secondary Curriculum Development
Albany 1965

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FOREWORD

During the past few years many changes have taken place in the mathematics curriculum. These changes have been implemented in various degrees in different schools. With the advent of a Regents examination in ninth year mathematics, it became obvious that neither of the two printed state courses of study at this level was ideal as a basis for this examination. The course described in the syllabus *Mathematics 7-8-9* for Ninth Year Mathematics - Course I - Algebra does not reflect current practice in many schools that have adopted some recent recommendations, and an examination based on that program would, in effect, cause such schools to take a backward step. The program described in the series of new publications *Experimental Mathematics for the Ninth Year, Units 1-12*, is not yet complete and not in general use, hence trying to base an examination on it would not be practicable at this time.

The following outline presents the minimum material for which students of ninth year mathematics - course 1, algebra, will be responsible on Regents examinations in this subject beginning in June 1966. As a transitional outline, it is subject to revision in the near future as experience with the experimental materials provides evidence for further change.

This course of study was prepared under the direction of Frank Hawthorne, Chief, Bureau of Mathematics Education, with the assistance of members of his staff. The first draft was written by Evelyn B. Gutekunst, temporary curriculum associate, now at Columbia High School, East Greenbush. It was reviewed by the following teachers and supervisors of mathematics who contributed suggestions for its improvement:

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As was indicated in the supervisory letter of January 1965 announcing the Regents examination in ninth year mathematics, the use of this examination is on a basis of local option. Although schools are encouraged to administer this examination, passing it is not required for a Regents diploma.

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NINTH YEAR MATHEMATICS

Course I - Algebra

Scope and Content

I Sets

A. Concept of sets

1. A *set* is a collection of objects.
2. These objects are called *members* or *elements* of the set.
3. Notation of sets: A = {1, 5, 6, 7}, read A is the set consisting of 1, 5, 6, and 7.
   $\{x \mid x \in A\}$, read all x such that x is an element of A.

B. Subsets, matching sets - finite sets.

1. A *subset* of set B is a set A every element of which is an element of the superset B.
2. A *proper subset* of set B is a set A which contains some, but not all the elements of the superset B.
3. *Matching sets* - sets which have a one-to-one correspondence, sets which have the same number of elements. These are also called *equivalent* sets.
4. *Finite set* is a set which has a definite number of elements.
   A = {1, 3, 5, 7, 9}
5. *Infinite set* is a set which has an infinite number of elements.
   A = {1, 3, 5, 7, 9,...} indicating all the positive odd integers.
6. *Null set*, the empty set - the set containing no elements, symbolized {} or ϕ.
7. *Universal set* the largest set under consideration, symbolized U.
   U = {1, 2, 3, 4, 5, 6}
   A = {1, 3, 5}, the subset of U containing the odd numbers in U.

C. Solution set.

1. The answer (or answers) to a problem and the root (or distinct roots) of an equation may be listed as the elements of a set, called the *solution set.*
2. Notation for the solution set
   a. $2x + 3 = x + 7$
      The solution set for this equation is {4}
   b. $x^2 + 3x - 4 = 0$
      The solution set for this equation is {1, -4}

II Arithmetic

A. Throughout the course emphasis should be placed on the integration of the three phases of mathematics; arithmetic, algebra, and geometry. Basic arithmetical skills should be reviewed and extended in connection with algebraic processes and principles.

B. Square root of numbers.

C. Approximations - "rounding off."

D. Significant digits

III Algebra

A. Language and ideas

1. Algebraic representation
2. Use of algebraic principles in arithmetical techniques. For example, percentage worked with x representing the unknown, rather than using a percentage rule. [82% of the students were present today. How many students are enrolled if 574 were present today?
   $.82x = 574$, $x = 700$]

B. Laws of Algebra (or postulates of the field of real numbers)

1. *Commutative property* under addition and multiplication.
   [$a + b = b + a$] [$ab = ba$]

2. *Associative property* under addition and multiplication.

   $[a + (b + c) = (a + b) + c]$ $[a(bc) = (ab)c]$

3. *Distributive law* - multiplication is distributive with respect to addition.

   $[a(b + c) = ab + ac]$

4. The *additive identity* element for the set of real numbers is 0.

   $[a + 0 = a]$

5. The *multiplicative identity* element for the set of real numbers is 1.

   $[a \cdot 1 = a]$

6. The *additive inverse* - For each real number there exists an additive inverse such that the sum of the real number and its additive inverse is zero.

   The additive inverse of a is -a

   $[a + (-a) = 0]$

   The additive inverse of -a is +a

   $[-a + (+a) = 0]$

7. The *multiplicative inverse* - For each real no. $\neq 0$ there exists a multiplicative inverse such that the product of the real number and its multiplicative inverse is 1. The multiplicative inverse is also called the *reciprocal*.

   The multiplicative inverse of $\frac{a}{b}$ is $\frac{b}{a}$, $(a \neq 0)$

   The multiplicative inverse of $-\frac{1}{a}$ is -a

8. *Closure*

   The closure property for addition means that the sum of any two elements in the set is a unique element of that set. The closure property for any operation means that when that operation is performed on any two elements of the set the result is also a member of the set. The set of natural numbers is closed under addition and multiplication. The set of integers is closed under subtraction as well as addition and multiplication. The set of odd integers is not closed under addition.

C. Properties of Equality

1. Reflexive property $[a = a]$
2. Symmetric property [if $x = y$, then $y = x$]

3. Transitive property [if $a = b$ and $b = c$ then $a = c$]
4. Substitution property
   A number or expression may be substituted for its equal in any expression.
5. Addition property
   If $a = b$ then $a + c = b + c$
6. Subtraction property
   If $a = b$ then $a - c = b - c$
7. Multiplication property
   If $a = b$ then $ac = bc$
8. Division property
   If $a = b$ then $\frac{a}{c} = \frac{b}{c}$ $(c \neq 0)$

D. Principles and processes

1. Fundamental processes
   a. addition - subtraction, multiplication and division of monomials.
   b. order of operation - combining like terms
   c. signed numbers
2. Polynomials - operation with polynomials
3. Special products and factoring
   a. product of a polynomial and a monomial
   b. product of two binomials, squaring a binomial
   c. factoring: to include the common monomial factor, the difference of two squares, and factorable quadratic trinomials.
4. Algebraic fractions, limited to simple cases involving monomial denominators in addition and subtraction and binomial and trinomial numerators and denominators in multiplication and division.
5. Formula - evaluation - transformation and interpretation.
6. Exponents (positive, integral)
7. Square root - radicals
   a. Simplification of radicals

      $\sqrt{12} = 2\sqrt{3}$

   b. Combining like radicals

      $\sqrt{48} - \sqrt{75} + 2\sqrt{27} = 2\sqrt{3}$

8. Ratio and proportion
Review and extension to cover all applications significant at the ninth grade level.

9. Solution of equations, linear in one and two variables, fractional equations limited to monomial denominators. The quadratic by factoring. Problems involving solution of equations. Applications including number problems, digit problems, business problems, motion problems, work problems, investment problems, mixture problems, geometric problems.

E. Inequalities

1. Symbolism
   - $\neq$ is not equal to
   - $>$ is greater than
   - $<$ is less than
   - $\geq$ is greater than or equal to
   - $\leq$ is less than or equal to

   [Example: $3 \leq x < 7$ read x is equal to or greater than three and less than 7]

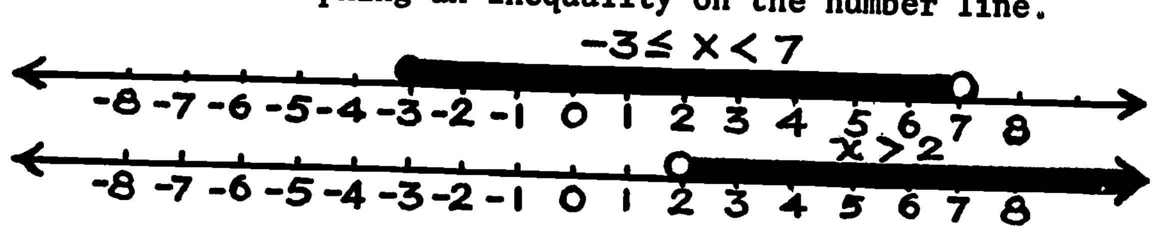
2. Types of inequalities
   absolute inequality, one which is always true [$x + 3 > x$] for all x
   conditional inequality, an inequality which is true for at least one, but not all the elements of the replacement set.

3. *Replacement set*, the set of all permissible replacements for a variable. This replacement set is called the *domain* of the variable.

4. Solving a linear inequality.
   $x + 2 > 3$ Ans. $\{x \mid x > 1\}$

5. Absolute value
   The absolute value of x symbolized $|x|$, is never negative.
   $|x| = x$ when x is a positive number of 0
   $|x| = -x$ when x is a negative number.

6. Graphing an inequality on the number line.



IV The coordinate system

A. Concept of the coordinate system as a one-to-one correspondence between the set of points in the plane and the set of ordered pairs of real numbers. Significance of the order of the members of an ordered pair.

B. Graph of the straight line.

$y = a$ (parallel to x-axis or the x-axis itself)

$x = a$ (parallel to y-axis or the y-axis itself)

$y = mx$ (passing through the origin)

$y = mx + b$ (slope intercept form)

<u>m</u> is the slope - rise over run - change in y over change in x

<u>b</u> is the y-intercept - the ordinate of the point at which the line crosses the y-axis.

C. Graphic solution of linear systems.

inconsistent system - (equations whose graphs are parallel lines)

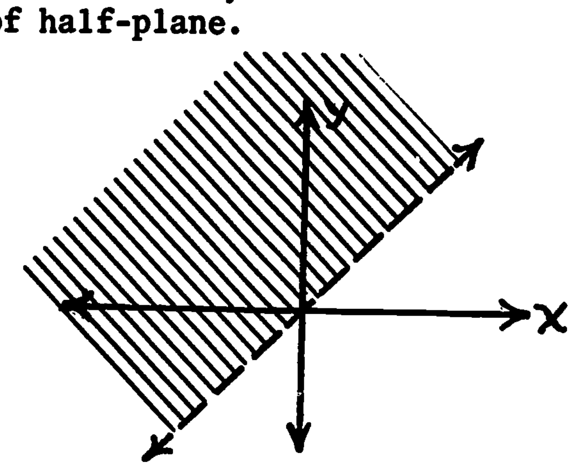
dependent system (equations whose graphs are the same straight line)

simultaneous equations (consistent and independent, equations whose graphs intersect in one point)

D. Graphing of linear inequalities

Graphic solution of systems of linear inequalities, meaning of half-plane.

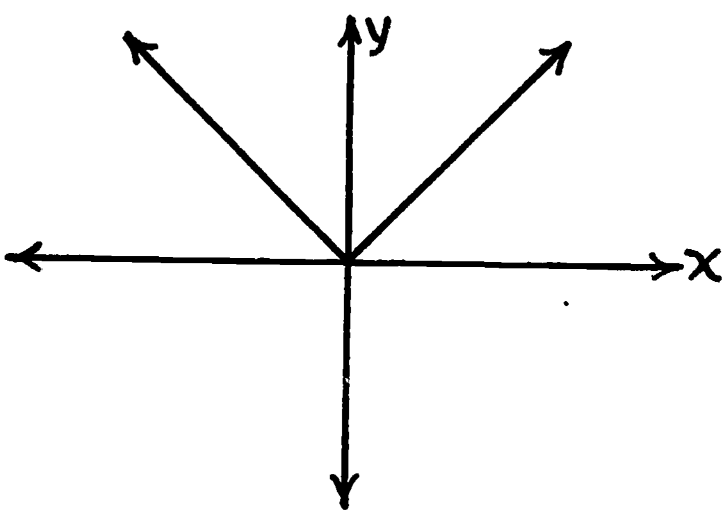
<u>Example</u>:



the shaded area is the half-plane representing $y > x$

E. Graphing equations involving the absolute value of a variable

<u>Example</u>: $y = |x|$



V Geometry

A. Formulas

1. Area of rectangle = bh
2. Area of parallelogram = bh
3. Area of triangle = $\frac{1}{2}$ bh
4. Sum of the angles of a triangle = 180°
5. In a right triangle, $c^2 = a^2 + b^2$
6. Area of circle = πr^2
7. Circumference of circle = $2\pi r$
8. Perimeter of rectangle = $2l + 2w$
9. Perimeter of square = 4s

B. Algebraic problems relating to geometry. [Finding the diagonal of a rectangle by use of the Pythagorean theorem for example, or finding the vertex angle of an isosceles triangle when one base angle is given.] Problems involving supplementary and complementary angles.

VI Indirect measurement and trigonometry

A. Concepts of indirect measurement
Indirect measurement is a result of numerical computation.

B. Similar triangles - properties of similar triangles - use of similar triangles to find unknown distances.

C. The sine, cosine and tangent ratios

D. The use of trig tables (no interpolation)

E. The solution of problems involving the use of trig functions in the right triangle. Understanding the angle of depression and angle of elevation.

Since the pupils studying this course will have different backgrounds, the teacher will need to adjust the time schedule to his particular class. This guide is intended to be very flexible, serving mainly to point out the areas where most time will need to be spent and thus emphasizing the danger of lingering too long in any one unit.

	Topic	Approximate Number of Days
I	Study of sets	5
II	Arithmetic processes - square root	5
III	Algebraic representation	5
IV	Laws of algebra - properties	5
V	Fundamental processes	15
VI	Polynomials	10
VII	Special products and factoring	15
VIII	Algebraic fractions	10
IX	Formulae	5
X	Exponents - radicals	5
XI	Ratio and Proportion	5
XII	Solution of equations - problems (one and two unknowns)	20
XIII	Properties of numbers	5
XIV	Inequalities - absolute value	10
XV	Coordinate system	10
XVI	Geometry	5
XVII	Indirect measurement and trigonometry	10
		145 days

Suggestions for Teaching

I Sets

This topic will need to be carefully presented and thoroughly explored in some classes, while a quick review will suffice in other groups which have been exposed to set concepts in the lower grades.

A set is always described so that you can tell whether or not an object belongs to the set. A set may be described in words, the set of all even integers, or by listing the elements of the set within braces. A = {1, 2, 5, 6, 7} read, A is the set containing the elements 1, 2, 5, 6, and 7. Subsets of A would be {1, 2, 5, 6}, {1, 2, 5}, {1}, {1, 6, 7} etc. These are proper subsets since they contain some, but not all the elements of the universal set. The set K = {1,2,5,6,7} is also a subset of A, since any set is a subset of itself. This is not a proper subset, but rather an improper subset. The two sets, K and A, are equal or identical. The null set is a proper subset of every set. A matching, or equivalent set for A is B = {6, 9, 4, 3, 8} which has the same number of elements as A.

Infinite sets are usually written with three dots after the last element listed, for example the set of all even natural numbers would be {2, 4, 6, 8,...} Three dots also symbolize elements of a set which have not been listed but continue in the same pattern to a certain last member. For example, the set of all even integers between 1 and 100 would be listed as {2, 4, 6,..., 98}. Care must be taken not to confuse sets containing an indeterminate number of elements, but still finite, with sets which are infinite. All the trees in the world, all the grains of sand on the beach, all the flies in the world, are examples of finite sets, although the actual number can not be determined. Examples of infinite sets are the integers, the set of real numbers, the set of even natural numbers or the set of points on a line segment.

The null set is the set containing no elements, there is only one such set and it is referred to as the null set. Do not confuse {0} with the null set, {0} is the set containing the element 0. $a + x = a$, the solution set for this equation is {0}, the identity element for addition. The null set is symbolized {} or ϕ. The solution set for $x + 3 = x$ is ϕ.

Solution set

Students should become familiar with the symbolism for the solution set and the set language of the equation. The set of real solutions of the equation $x^2 - 5x + 6 = 0$ can be expressed $\{x \mid x^2 - 5x + 6 = 0\}$, read all x such that $x^2 - 5x + 6 = 0$. The solution set is {2, 3}. $\{x \mid x + 3 > 7\}$ is read the set of all x such that x + 3 is greater than 7. The solution set for this inequality is $\{x \mid x > 4\}$. Emphasize the fact that the answers are elements of the solution set. The solution set contains all those elements and only those elements which when substituted into the original open sentence form a true sentence. The term "open sentence" should be used in preference to equation since an open sentence is any sentence containing a variable, which will include both equations and inequalities.

II Arithmetic

At all times the continuity of mathematics should be emphasized. Sequential reasoning and a logical amplification of basic principles will result in appreciation and understanding of the structure of mathematics. Examples in algebra should be of reasonable difficulty to provide review in the basic fundamentals.

Square root should be reviewed at this level and extended to include the square root of decimals. The "divide and average" method is suggested but any correct method which students have already learned is acceptable.

Although an intensive study of approximation and significant digits should not be undertaken at this time, the topic must be given some consideration. "Rounding off" can be summarized by the following rule.

"All numerical results, before they are stated in final form, should be obtained with at least one more digit than the number of significant digits allowed by the approximate data. Then this last digit is rounded off." "Quoted from the Twelfth Yearbook of the National Council of Teachers of Mathematics, page 54.)

The digits 1 through 9 are called significant digits. The number 0 may or may not be significant. It is significant when placed between other digits. It is not, when it is used as a place holder. In general this rule can be used to determine the significant digits of a number.

1. Disregard all initial zeros.
2. Disregard all final zeros unless they follow a decimal point.
3. The remaining digits are significant.

In a measurement of 23.0 inches the zero is significant since the measurement has been taken to tenths. In 2400 feet we shall usually assume this has been rounded to the nearest hundred, although this might represent three or four place accuracy. If numbers are given in scientific notation all the digits in the first factor are significant. Thus 3.40×10^2 contains 3 significant digits.

III Algebra

The fundamental laws of arithmetic become the fundamental laws of algebra when algebraic representation is used. The commutative property implies that two elements can be combined under addition or multiplication without regard for the order in which the combining is performed. The associative property implies that in a sum of several terms, any set may be added first, and in any product of several factors any set of factors may be multiplied together first. These are useful when combining several terms of unlike signs. $+7x - 3x + 4x - 6x - 3x + 5x$ is more easily accomplished by grouping the positive terms and combining, and then grouping the negative terms. Thus $+16x - 12x = +4x$. In presenting the distributive law confusion may result if all forms are not used. The multiplier may be left hand or right hand, the signs may be positive or negative. Examples follow.

$a(b + c) = ab + ac$

$(b + c)(a) = ba + ca = ab + ac$

$a(b - c) = ab - ac$

$(b - c)a = ba - ca = ab - ac$

When multiplication of binomials is introduced point out the use of the distributive law when multiplying (a + b) (c + d), a multiplied by each term of the second binomial and then b by each term of the second binomial. Thus (a + b)(c + d) becomes ac + ad + bc + bd, combining terms when possible.

$$(2 + x)(3 - 4x) = 6 - 8x + 3x - 4x^2 = 6 - 5x - 4x^2$$

Some time should be spent on the use of the multiplicative inverse, or reciprocal. Students may be using the old rule for division of fractions, "invert the divisor and multiply." Precaution on the part of the teacher always to employ the correct terminology "use the multiplicative inverse to transform the denominator to 1" will help to erase this meaningless procedure.

Closure is an important concept in the structure of the number system and should be fully understood. This topic is developed in Unit III of the 9X syllabus, background material for teachers. However a few examples at this point may be helpful.

A = {1, 2, 3, 4, 5,...}, (the set of natural numbers)

The set of natural numbers is closed under addition. 2 + 3 = 5, 7 + 9 = 16. Both 5 and 16 are elements of the set. It is also closed under multiplication. 3 x 5 = 15   10 x 12 = 120. Both 15 and 120 are elements of the set. The set of natural numbers is not closed under subtraction.

5 - 10 = -5, not a member of the set.

The set of natural numbers is not closed under division.

$3 \div 6 = \frac{1}{2}$, not a member of the set.

The set of integers is closed under subtraction, since it includes negative integers. The set of rational numbers is closed under division since it includes fractions.

The properties of equality may be illustrated by numerical examples. This is also a neat approach to inverse operations.

$$\begin{array}{rcl} 7 - 3 & = & 4 \\ +\ 3 & & +\ 3 \\ \hline 7 & = & 4 + 3 \end{array} \quad \text{(addition property)}$$

Thus showing addition and subtraction to be inverse operations.

or $8 \div 4 = 2$

$\frac{8}{4}(4) = 2\ (4)$ multiplication property

$8 = 2\ (4)$ thus showing division and multiplication to be inverse operations.

Principles and processes

If the meaning of <u>term</u> is fully understood to be a numeral or variable or an expression written as a product or quotient of numerals or variables or both, the concept of the laws of order is easier to master. The laws of order may be thought of as merely combining terms after each term has been simplified.

Work with radicals can be expanded if the time allows. This is an area which becomes increasingly important in math 10, 11 and 12 and any foundation work which can be done now will be helpful. Although rationalizing the denominator is not required it would be well to include it as part of simplification.

$$\sqrt{28} = \sqrt{4}\ \sqrt{7} = 2\sqrt{7}$$

$$\frac{1}{2} = \frac{\sqrt{1}}{\sqrt{2}} = \frac{1}{\sqrt{2}}\ \frac{(\sqrt{2})}{(\sqrt{2})} = \frac{\sqrt{2}}{2}$$

$$\frac{2}{\sqrt{3} - 1}\ \frac{(\sqrt{3} + 1)}{(\sqrt{3} + 1)} = \frac{2\sqrt{3} + 2}{3 - 1} = \frac{2\sqrt{3} + 2}{2} = \sqrt{3} + 1$$

Multiplying and dividing radicals which have the same index should be presented.

$$\sqrt{3} \cdot \sqrt{7} = \sqrt{21} \qquad \frac{\sqrt{33}}{\sqrt{3}} = \sqrt{11}$$

Inequalities

Some students may have explored this topic thoroughly, while others may be completely unfamiliar with it. The symbols may be related to the arrows on the number line.

$\rightarrow$, in a positive direction > is greater than
$\leftarrow$, in a negative direction < is less than.

Or you can remember the arrowhead always points to the smaller number. In solving conditional inequalities the properties of inequalities should be presented. They will cause little difficulty if c is restricted to positive numbers. Thus

if $a > b$, $a + c > b + c$
if $a > b$, $a - c > b - c$
if $a > b$ $ac > bc$
if $a > b$ $\frac{a}{c} > \frac{b}{c}$

Likewise if $a < b$ these properties hold true.
The transitive property for inequalities, if $a > b$ and $b > c$ then $a > c$ is sometimes stated, if the first of three quantities is greater than the second and the second is greater than the third, then the first is greater than the third.

The term variable is often misunderstood. It is closely related to the replacement set and these terms should be discussed together.

The expression $x + 1$ contains the variable x. This symbol x is a variable because it can be replaced by a number selected from a given set of possible replacements. The set of possible replacements is called the replacement set. If the replacement set for x is all positive integers, then the expression $x + 1$ will have an infinite number of values also. If the replacement set for x is $\{1, 3, 5, 7\}$ then the values of $x + 1$ will be $\{2, 4, 6, 8\}$. The replacement set of the variable is also called the domain. In the absolute inequality $x + 2 > x$ if the replacement set is all real numbers, then the inequality is true for all x. A conditional inequality such as $3x + 4 > x + 12$ is true for some, but not all, members of the replacement set of all real numbers. All $x > 4$ will make the inequality a true statement. Sometimes an inequality will have no value of the variable which will make a true statement. $x + 2 < x$. The solution set is the null set, {} or ϕ.

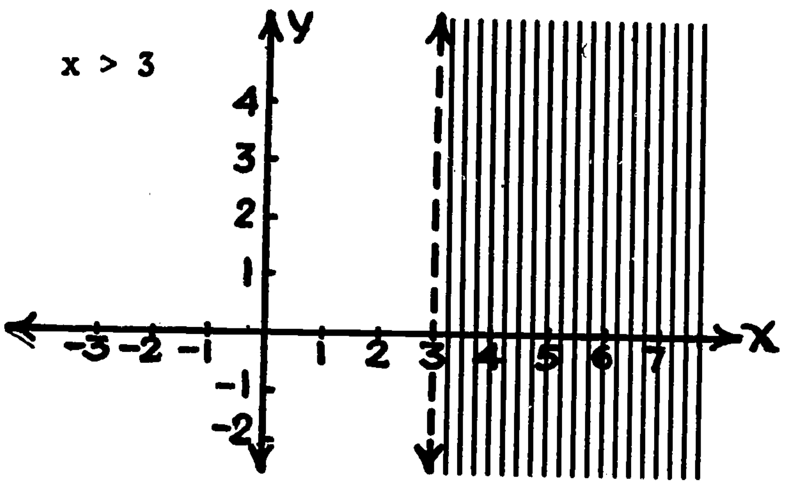
A study of the number line will make the meaning of absolute value clearer. One can think of the absolute value of a number as its distance from 0 on the number line, disregarding its direction. +5 is five units from 0, -5 is five units from zero. Both of these numbers have an absolute value of 5. The absolute value is never negative. It is sometimes referred to as the numerical value.

IV The coordinate system

In studying the coordinate system important concepts should be developed which will be of very great use in further work in mathematics. The coordinate plane has an infinite number of points and each point has an ordered number pair associated with it. Every point which has an x coordinate of 6, (or an abscissa of 6) lies on a line parallel to the y axis. Every point which has a y coordinate of 4 (or an ordinate of 4) lies on a line parallel to the x axis. By graphing the lines $x = 6$, and $y = 4$ it is obvious they will intersect at one point, (6, 4). Therefore there is a unique point which has an abscissa of 6 and an ordinate of 4. The slope intercept form for the straight line should be introduced at this point. Slope indicates the steepness of the line, the tilting of the line, an oblique line with slope m; in contrast to a line parallel to the y axis with no slope, or a line parallel to the x axis with a slope of 0. At this level the terminology "rise over run" might be helpful in presenting the slope. The change in y over the change in x might be called the "rise" (change in y in a positive direction), over "run," (change in x, positive direction for a positive slope, or negative direction to the left, for a negative slope). $y = mx + b$ is the equation for a straight line with m indicating the slope and b indicating the y-intercept. Time should be taken to fix firmly the meaning of the y-intercept. Too often a lasting wrong impression exists in this area. The y-intercept is not a point, it is the <u>ordinate</u> of the point at which the line crosses the y axis. The line intersects the y axis at (0, b). The y-intercept is the second coordinate of the point, the y-intercept is b. Also the x intercept is the abscissa of the point at which the line crosses the x axis. Confusion also exists when distinguishing between the slope of a line parallel to the x axis, with slope 0, and that of a line parallel to the y axis with no slope. Time spent here to clarify this difficult concept will eliminate many future difficulties.

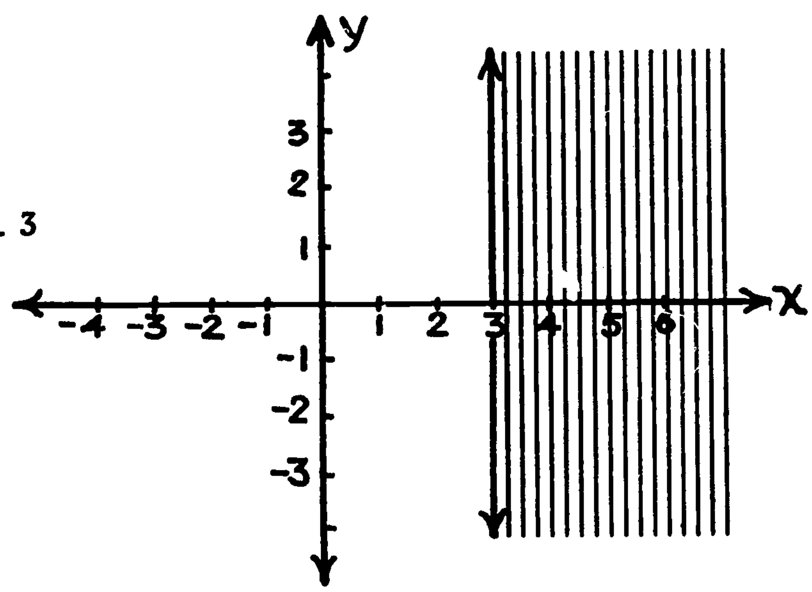
In graphing the straight line on a coordinate system, points may be plotted to determine the line, but students should soon learn to plot by the intercept-slope method in order to more fully understand systems of linear equations. Parallel lines have the same slope and such lines form an inconsistent system. If two equations such as $3y = 5x - 2$ and $10x - 6y = 4$ are graphed on the same axes their graphs are the same straight line and the equations are called a dependent system. Equations whose graphs are intersecting straight lines form a consistent, independent system and have one point in common. The solution set for such a system is an ordered number pair, $\{(x, y)\}$.

A linear inequality can be graphed on the coordinate plane thus:



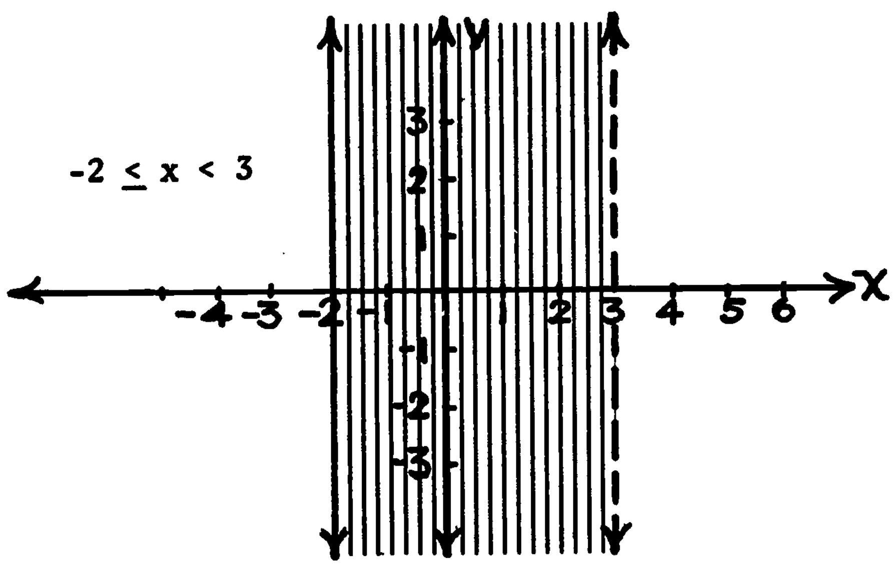
The dashed line indicates the line itself is not included in the solution. However x $\geq$ 3 is graphed with a solid line, indicating the line is included in the solution.

x $\geq$ 3



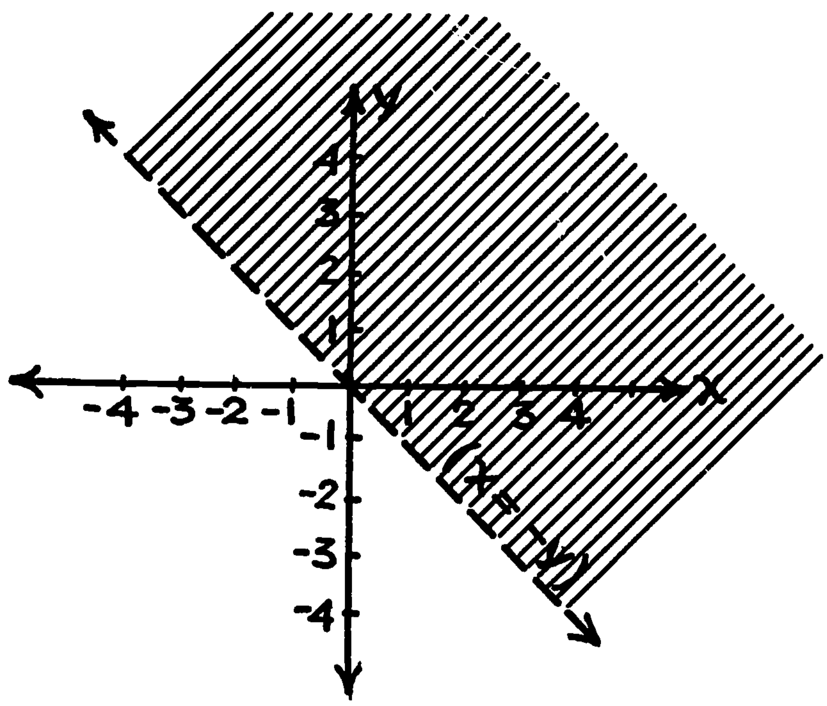
The inequality -2 $\leq$ x < 3, read x is greater than or equal to -2 and less than 3 would be graphed as below.

-2 $\leq$ x < 3

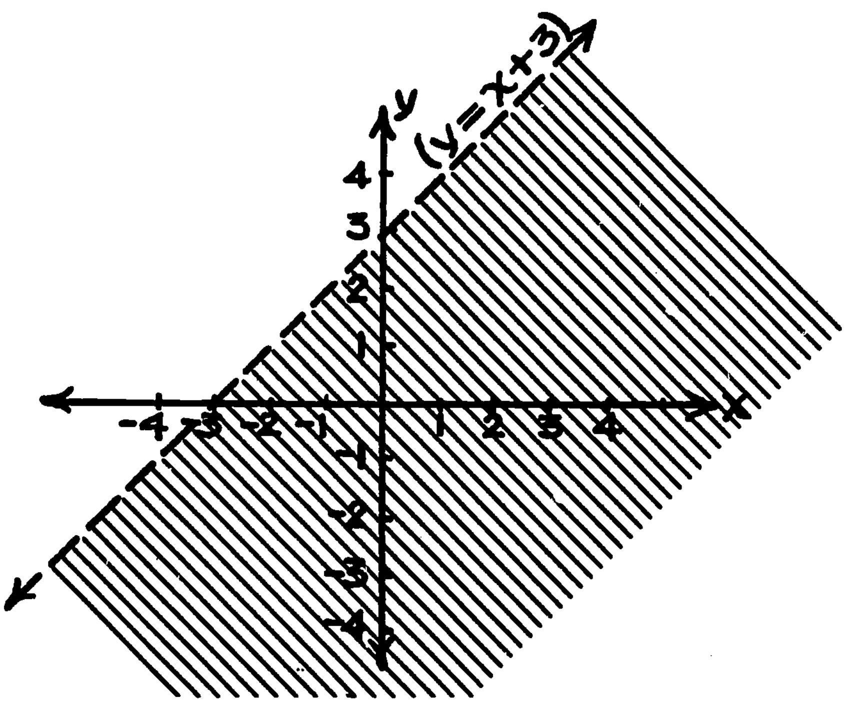


A half-plane is that part of the plane on one side of a straight line such as x = -y or y = x + 3.

x = -y or y = x + 3.



The shaded part is the half-plane representing x > -y or x + y > 0. The unshaded part is the half-plane representing x < -y or x + y < 0. The line is in neither half-plane.



The shaded part is the half-plane representing y < x + 3. The unshaded part is the half-plane representing y > x + 3.

V Geometry

The work in geometry on the ninth grade level is a continuation and reinforcement of the work done in the seventh and eighth grades. The purpose of this unit is to acquaint the student with the figures of geometry, their importance and the use of formulas for mensuration. Familiarity with the vocabulary of geometry and an appreciation of sequence will give a helpful preparation for formal geometry in tenth year mathematics.

VI Indirect measurement and trigonometry are closely related to the unit on geometry. Indirect measurement should be understood to be a result of computation, in contrast to direct measurement. Since indirect measurement is based on some direct measurements it is no more exact than direct measurement. Students should be made aware of the fact that no measurement is exact and is correct only to a certain degree of precision. For instance 4 feet is greater than $3\frac{1}{2}$ feet, but less than $4\frac{1}{2}$ feet. 4.5 feet is greater than 4.45 feet but less than 4.55 feet.

The properties of similar triangles should be reviewed so that distances can be found by use of the fact that corresponding sides are in proportion. Work with the trigonometric functions should be restricted to the sine, cosine, and tangent ratios. Computation should be applied only to problems limited to right triangles although students should be made aware of the possibilities which exist in an oblique triangle. Students should become familar with the use of angles of depression and elevation. Problems related to trigonometry supply excellent material which will help integrate arithmetic, algebra, and geometry.