

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

KINDERGARTEN

By the end of kindergarten, students understand the consistency of small numbers, quantities and simple shapes in their everyday environment. They count, compare, describe and sort objects, and develop a sense about properties and patterns.

NUMBER SENSE

- 1.0 Students understand the relationship between numbers and quantities, i.e., that a set of objects; has the same number of objects in different situations, regardless of its position or arrangement.
 - 1.1 compare two or more sets (up to 10 objects in each group), and identify which set is equal to, more than, or less than the other
 - 1.2 count, recognize, represent, name and order numbers (to 30) using objects
 - 1.3 know that the larger numbers describe sets with more objects in them than smaller numbers
- 2.0 Students understand and describe simple addition and subtraction situations.
- 3.0 Students use concrete objects to determine the answers to addition and subtraction problems for two numbers each less than 10.
- 4.0 Students use estimation strategies in computation and problem solving that involve numbers that use the ones and tens places and recognize when an estimate is reasonable.

ALGEBRA AND FUNCTIONS

- 1.0 Students sort and classify objects.
 - 1.1 identify, sort and classify objects by attribute and identify objects that do not belong to a particular group (e.g., all these balls are green, those are red)
 - 1.2 identify, describe, and extend simple patterns according to shape, size, or color; or two or more of these attributes

MEASUREMENT AND GEOMETRY

- 1.0 Students understand that there are properties such as length, weight, capacity and time and that comparisons can be made by using these properties.

- 1.1 compare the length, weight and capacity of objects by making direct comparisons or using reference objects (e.g., shorter/longer/taller, lighter/heavier, which holds more?)
 - 1.2 demonstrate understanding of concepts of time (e.g., morning, afternoon, evening, day, yesterday, tomorrow, week, year) including tools that measure time (e.g., clock, calendar)
 - 1.3 name the days of the week
 - 1.4 identify the time (to the nearest hour) of everyday events (e.g., lunch time is 12 o'clock, bed time is 8 o'clock at night)
- 2.0 Students identify common geometric objects in their environment and describe their features.
- 2.1 identify and describe common geometric objects (e.g., circle, triangle, square, rectangle, cube, sphere, cone)
 - 2.2 compare familiar plane and solid objects by common attributes (e.g., position, shape, size, roundness, number of corners)

STATISTICS, DATA ANALYSIS and PROBABILITY

- 1.0 Students collect information about objects and events in their environment.
- 1.1 pose information questions, collect data and record the results using objects, pictures and picture graphs
 - 1.2 identify, describe and extend simple patterns involving shape, size, or color (e.g., circle, triangle, or red, blue)

MATHEMATICAL REASONING

- 1.0 Students make decisions about how to set up a problem.
- 1.1 decide about the approach, materials and strategies to use
 - 1.2 use tools and strategies such as manipulatives or sketches to model problems
- 2.0 Students solve problems in reasonable ways and justify reasoning.
- 2.1 use estimation to verify the reasonableness of calculated results
 - 2.2 explain the reasoning used with concrete objects and pictorial representations
 - 2.3 make precise calculations and check the validity of the results from the context of the problem

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GRADE 1

By the end of first grade, students understand and use the concept of "ones" and "tens" in the place value number system. They add and subtract small numbers with ease. They measure with simple units and locate objects in space (e.g., positional words: above and below). They describe data and analyze and solve simple problem situations.

NUMBER SENSE

- 1.0 Students understand and use numbers up to 100.
 - 1.1 count, read and write whole numbers to 100
 - 1.2 compare and order whole numbers to 100 using the symbols for less than, equal to, or greater than ($<$, $=$, $>$)
 - 1.3 represent equivalent forms of the same number through the use of physical models, diagrams and number expressions to 20 (e.g., 8 can be represented as $4 + 4$, $5 + 3$, $2 + 2 + 2 + 2$, $10 - 2$, or $11 - 3$)
 - 1.4 count and group objects into ones and tens (e.g., 3 groups of ten and 4 more is 34 or $30 + 4$)
 - 1.5 identify and know the value of coins and show different combinations of coins that equal the same value
- 2.0 Students demonstrate the meaning of addition and subtraction and use these operations to solve problems.
 - 2.1 show the meaning of addition (putting together, increasing) and subtraction (taking away, comparing, finding the difference)
 - 2.2 know and commit to memory the addition facts (sums to 20) and the corresponding subtraction facts
 - 2.3 use the inverse relationship between addition and subtraction to solve problems
 - 2.4 identify one more than, one less than, ten more than, ten less than a given number
 - 2.5 count by 2s, 5s and 10s with numbers to 100
 - 2.6 solve addition and subtraction problems with one- and two-digit numbers (e.g., $5 + 58 = \underline{\quad}$)

- 2.7 find the sum of three one-digit numbers
- 3.0 Students use estimation strategies in computation and problem solving that involve numbers that use the ones, tens, and hundreds places.
- 4.0 Students make reasonable estimates when comparing larger or smaller numbers.

ALGEBRA AND FUNCTIONS

- 1.0 Students use number sentences to solve problems using objects, drawings, symbols, and words.
 - 1.1 understand the meaning of the symbols +, -, and =
 - 1.2 write and solve number sentences from problem situations that express relationships involving addition and subtraction
 - 1.3 create problem situations that could lead to given number sentences involving addition and subtraction

MEASUREMENT AND GEOMETRY

- 1.0 Students use direct comparison and non-standard units to describe the measurements of objects.
 - 1.1 compare the length, weight and volume of two or more objects using direct comparison or a non-standard unit
 - 1.2 tell time to the nearest half hour and compare time related to events (e.g., before/after, shorter/longer)
- 2.0 Students identify common geometric figures, classify by common attributes and describe relative position or location in space.
 - 2.1 identify, describe, and compare triangles, rectangles, squares and circles, including the faces of three-dimensional objects
 - 2.2 classify familiar plane and solid objects by common attributes like color, position, shape, size, roundness, and number of corners; explain which attributes are being used for classification
 - 2.3 follow and give directions about location
 - 2.4 describe and arrange objects in space in terms of proximity, position and direction (e.g., near, far, below, above, up, down, behind, in front of, next to, left/right)

STATISTICS, DATA ANALYSIS and PROBABILITY

- 1.0 Students organize, represent and compare categorical data on simple graphs and charts.

- 1.1 sort objects and data by common attributes and describe the groups formed using categorical labels
 - 1.2 represent and compare data (e.g., largest, smallest, most often, least often), using pictures, bar graphs, tally charts and picture graphs
- 2.0 Students sort objects and create and describe patterns involving number, shape, size, rhythm, or color.
- 3.0 Students describe, extend and explain how to get to the next element in simple repeating patterns (e.g., rhythmic, numeric, color and shape patterns).

MATHEMATICAL REASONING

- 1.0 Students make decisions about how to set up a problem.
- 1.1 decide about the approach, materials and strategies to use
 - 1.2 use tools such as manipulatives or sketches to model problems
- 2.0 Students solve problems and justify their reasoning.
- 2.1 use estimation to verify the reasonableness of calculated results
 - 2.2 explain the reasoning used and justify the strategies selected
 - 2.3 make precise calculations and check the validity of the results from the context of the problem
- 3.0 Students note connections between one problem and another.

Tustin Unified School District

Mathematics Content Standards

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GRADE 2

By the end of second grade, students understand place value and number relationships as they add and subtract and they use simple concepts of multiplication. They measure quantities with appropriate units. They classify and see relationships among shapes by paying attention to the elements that compose them. They collect and analyze data and verify answers.

NUMBER SENSE

- 1.0 Students understand the relationship among numbers, quantities and place value in whole numbers up to 1000.
 - 1.1 count, read, and write whole numbers to 1,000 and identify the place value for each digit
 - 1.2 use words, models and expanded form to represent numbers to 1,000
 - 1.3 order and compare whole numbers up to 1,000 using the symbols $<$, $=$, and $>$
- 2.0 Students estimate, calculate and solve problems involving addition and subtraction of two- and three-digit numbers with and without regrouping.
 - 2.1 understand and use the inverse relationship between addition and subtraction (e.g., an opposite number sentence for $8 + 6 = 14$ is $14 - 6 = 8$) to solve problems and check solutions
 - 2.2 find the sum or difference of two whole numbers up to three digits long
 - 2.3 use mental arithmetic to find the sum or difference of two 2-digit numbers
- 3.0 Students model and solve simple problems involving multiplication and division.
 - 3.1 use repeated addition, arrays, counting by multiples to do multiplication
 - 3.2 use repeated subtraction, equal sharing and forming equal groups to do division with remainders
 - 3.3 know and commit to memory the multiplication tables of 2s, 5s, and 10s (to "times 10")
- 4.0 Students understand that fractions and decimals can refer to parts of a set and parts of a whole.
 - 4.1 recognize, name and compare unit fractions up to $1/12$
 - 4.2 recognize fractions of a whole and parts of a group (e.g., $1/4^{\text{th}}$ of a pie, $2/3^{\text{rds}}$ of 15 balls)

- 4.3 know that when all fractional parts are included, such as $\frac{4}{4}$, the result is equal to the whole and to “1”
- 5.0 Students model and solve problems by representing, adding and subtracting amounts of money.
 - 5.1 solve problems using combinations of coins and bills
 - 5.2 know and use the decimal notation and the dollar sign or cents symbol for money
- 6.0 Students use estimation strategies in computation and problem solving that involve numbers that use the ones, tens, hundreds, and thousands places.
- 7.0 Students recognize when an estimate is reasonable in measurements (e.g., closest inch)

ALGEBRA AND FUNCTIONS

- 1.0 Students model, represent and interpret number relationships to create and solve problems involving addition and subtraction.
 - 1.1 use the commutative and associative rules to simplify mental calculations and check results
 - 1.2 relate problem situations and number sentences involving addition and subtraction
 - 1.3 solve addition and subtraction problems using data from simple charts, picture graphs, and number sentences

MEASUREMENT AND GEOMETRY

- 1.0 Students understand that measurement is accomplished by identifying a unit of measure, repeating that unit and comparing it to the item to be measured.
 - 1.1 measure the length of objects by repeating a non-standard or standard unit
 - 1.2 use different units to measure the same object and predict whether the measure will be greater or smaller when a different unit is used
 - 1.3 measure the length of an object to the nearest inch and/or centimeter
 - 1.4 tell time to the nearest quarter hour and know time relationships (e.g., minutes in an hour, days in a month, weeks in year)
 - 1.5 determine the duration of time intervals in hours (e.g., 11:00 a.m. to 4:00 p.m.)
- 2.0 Students identify and describe the elements that compose common figures in the plane and common objects in space.

- 2.1 describe and classify plane and solid geometric shapes (e.g., circle, triangle, square, rectangle, sphere, pyramid, cube, rectangular prism) according to the number and shape of faces, edges and vertices
- 2.2 put shapes together and take them apart to form other shapes (e.g., two congruent right triangles can form a rectangle)

STATISTICS, DATA ANALYSIS AND PROBABILITY

- 1.0 Students collect, record, organize, display and interpret numerical data on bar graphs and other representations.
 - 1.1 record numerical data in systematic ways, keeping track of what/who has been counted
 - 1.2 represent the same data set in more than one way (e.g., charts with tallies, and bar graphs)
 - 1.3 identify features of data sets (range and mode)
 - 1.4 ask and answer simple questions related to data representations
- 2.0 Students demonstrate an understanding of patterns and how they grow and describe them in general ways.
 - 2.1 recognize, describe, extend and explain how to get the next term in linear patterns (e.g., 4, 8, 12, ...; the number of ears on 1 horse, 2 horses, 3 horses, 4 horses, ...)
 - 2.2 solve problems involving simple number patterns

MATHEMATICAL REASONING

- 1.0 Students make decisions about how to set up a problem.
 - 1.1 decide about the approach, materials and strategies to use
 - 1.2 use tools such as manipulatives or sketches to model problems
- 2.0 Students solve problems and justify their reasoning.
 - 2.1 use estimation to verify the reasonableness of calculated results
 - 2.2 defend the reasoning used and justify the strategies selected
 - 2.3 make precise calculations and check the validity of the results from the context of the problem
- 3.0 Students note connections between one problem and another.

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GRADE 3

By the end of third grade, students deepen their understanding of place value and their understanding of and skill with addition, subtraction, multiplication and division of whole numbers. They estimate, measure and describe objects in space. They use patterns to help solve problems. They represent number relationships and conduct simple probability experiments.

NUMBER SENSE

- 1.0 Students understand place value of whole numbers.
 - 1.1 count, read, and write whole numbers to 10,000
 - 1.2 compare and order whole numbers to 10,000
 - 1.3 identify the place value for each digit in numbers to 10,000
 - 1.4 round off numbers to 10,000 to the nearest ten, hundred and thousand
 - 1.5 use expanded notation to represent numbers (e.g., $3,206 = 3,000 + 200 + 6$)
- 2.0 Students calculate and solve problems involving addition, subtraction, multiplication and division.
 - 2.1 find the sum or difference of two whole numbers between 0 and 10,000
 - 2.2 memorize to automaticity the multiplication table for numbers between 1 and 10
 - 2.3 use the inverse relationship of multiplication and division to compute and check results
 - 2.4 solve simple problems involving multiplication of multi-digit numbers by one-digit numbers ($3,671 \times 3 = ?$)
 - 2.5 solve division problems in which a multi-digit number is evenly divided by a one-digit number ($135 \div 5 = ?$)
 - 2.6 understand the special properties of 0 and 1 in multiplication and division
 - 2.7 determine the unit cost when given the total cost and number of units
 - 2.8 solve problems that combine two or more operations

- 3.0 Students understand the relationship between whole numbers, simple fractions and decimals.
- 3.1 compare fractions represented by drawings or concrete materials to show equivalency, and to add and subtract simple fractions in context (e.g., $1/2$ of a pizza is the same amount as $2/4$ of another pizza that is the same size; show that $3/8$ is more than $1/8$)
 - 3.2 add and subtract simple fractions (e.g., determine that $1/8 + 3/8$ is the same as $1/2$)
 - 3.3 solve problems involving addition, subtraction, multiplication and division of money amounts in decimal notation and multiply and divide money amounts in decimal notation using whole number multipliers and divisors
 - 3.4 know and understand that fractions and decimals are two different representations of the same concept (e.g., $50¢ = \$0.50 = 1/2$ of a dollar, $75¢ = \$0.75 = 3/4$ of a dollar)

ALGEBRA AND FUNCTIONS

- 1.0 Students select appropriate symbols, operations and properties to represent, describe, simplify and solve simple number relationships.
- 1.1 represent relationships of quantities in the form of mathematical expressions, equations, or inequalities
 - 1.2 solve problems involving numeric equations or inequalities
 - 1.3 select appropriate operational and relational symbols to make an expression true (e.g., $4 _ 3 = 12$, what operation symbol goes in the blank?)
 - 1.4 express simple unit conversions in symbolic form (e.g., #inches = #feet x 12)
 - 1.5 recognize and use the commutative and associative properties of multiplication (e.g., if $5 \times 7 = 35$, then what is 7×5 ?; if $(5 \times 7) \times 3 = 105$, then what is $5 \times (7 \times 3)$?)
- 2.0 Students represent simple functional relationships.
- 2.1 solve simple problems involving a functional relationship between two quantities (e.g., find the total cost of multiple items given the per unit cost)
 - 2.2 extend and recognize a linear pattern by its rules (e.g., the number of legs on a given number of horses can be calculated by counting by 4s or by multiplying the number of horses by 4)

MEASUREMENT AND GEOMETRY

- 1.0 Students choose and use appropriate units and measurement tools to quantify the properties of objects.
- 1.1 choose appropriate units (metric and U.S. customary) and tools, and estimate and measure length, liquid volume and weight/mass

- 1.2 estimate or determine the area and volume of solid figures by covering them with squares or by counting the number of cubes that would fill them
 - 1.3 find the perimeter of a polygon with integer sides
 - 1.4 carry out simple unit conversions within a system of measurement (e.g., centimeters and meters, hours and minutes)
- 2.0 Students describe and compare the attributes of plane and solid geometric figures and use their understanding to show relationships and solve problems.
- 2.1 identify, describe, and classify polygons (including pentagons, hexagons and octagons)
 - 2.2 identify attributes of triangles (e.g., two equal sides for the isosceles triangle, three equal sides for the equilateral triangle, right angle for the right triangle)
 - 2.3 identify attributes of quadrilaterals (e.g., parallel sides for the parallelogram, right angles for the rectangle, equal sides and right angles for the square)
 - 2.4 identify right angles in geometric figures or in appropriate objects and determine whether other angles are greater or less than a right angle
 - 2.5 identify, describe, and classify common three-dimensional geometric objects (e.g., cube, rectangular solid, sphere, prism, pyramid, cone, cylinder)
 - 2.6 identify the common solid objects that are the component parts needed to make a more complex solid object

STATISTICS, DATA ANALYSIS and PROBABILITY

- 1.0 Students conduct simple probability experiments by determining the number of possible outcomes, and make simple predictions.
 - 1.1 identify whether common events are certain, likely, unlikely, or improbable
 - 1.2 record the possible outcomes for a simple event (e.g., tossing a coin) and systematically keep track of the outcomes when the event is repeated many times
 - 1.3 summarize and display the results of probability experiments in a clear and organized way (e.g., use a bar graph or a line plot)
 - 1.4 use the results of probability experiments to predict future events (e.g., use a line plot to predict the temperature forecast for the next day)

MATHEMATICAL REASONING

- 1.0 Students make decisions about how to approach problems.

- 1.1 analyze problems by identifying relationships, discriminating relevant from irrelevant information, sequencing and prioritizing information, and observing patterns
- 1.2 determine when and how to break a problem into simpler parts
- 2.0 Students use strategies, skills and concepts in finding solutions.
 - 2.1 use estimation to verify the reasonableness of calculated results
 - 2.2 apply strategies and results from simpler problems to more complex problems
 - 2.3 use a variety of methods such as words, numbers, symbols, charts, graphs, tables, diagrams and models to explain mathematical reasoning
 - 2.4 express the solution clearly and logically using appropriate mathematical notation, terms and clear language, and support solutions with evidence, in both verbal and symbolic work
 - 2.5 indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy
 - 2.6 make precise calculations and check the validity of the results from the context of the problem
- 3.0 Students move beyond a particular problem by generalizing to other situations.
 - 3.1 evaluate the reasonableness of the solution in the context of the original situation
 - 3.2 note method of deriving the solution and demonstrate conceptual understanding of the derivation by solving similar problems
 - 3.3 develop generalizations of the results obtained and extend them to other circumstances

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Mathematics Content Standards

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GRADE 4

By the end of fourth grade, students understand large numbers and addition, subtraction, multiplication and division of whole numbers. They describe and compare fractions and decimals. They understand the properties of and the relationships between plane geometric figures. They collect, represent and analyze data to answer questions.

NUMBER SENSE

- 1.0 Students understand place value of whole numbers and decimals to two decimal places, how these relate to fractions, and use concepts of negative numbers.
 - 1.1 read and write whole numbers in the millions
 - 1.2 order and compare whole numbers and decimals to two decimal places
 - 1.3 round whole numbers through the millions to the nearest ten, hundred, thousand, ten thousand or hundred thousand
 - 1.4 decide when a rounded solution is called for, and explain why this is the case
 - 1.5 interpret different meanings for fractions including parts of a whole, parts of a set, indicated division of whole numbers and quantities (and measures) between whole numbers on a number line; and relate to simple decimals on a number line
 - 1.6 write the fraction represented by a drawing of parts of a figure; represent a given fraction using drawings
 - 1.7 convert improper fractions to mixed numbers and mixed numbers to improper fractions
 - 1.8 write tenths and hundredths in decimal and fraction notation and know fraction/decimal equivalents for halves and fourths (e.g., $\frac{1}{2} = 0.5$ or $.50$; $\frac{7}{4} = 1\frac{3}{4} = 1.75$)
 - 1.9 identify the relative position of fractions, mixed numbers, and decimals to two decimal places on the number line
 - 1.10 use concepts of negative numbers (e.g., on a number line, in counting, in temperature, "owing")
- 2.0 Students extend their use and understanding of whole numbers to addition and subtraction of simple decimals.

- 2.1 estimate and compute the sum or difference of whole numbers and positive decimals to two places
 - 2.2 round two place decimals to one decimal or the nearest whole number, and use rounding to judge the reasonableness of an answer
- 3.0 Students solve problems involving addition, subtraction, multiplication and division of whole numbers and addition and subtraction of integers, and understand the relationships among the operations.
- 3.1 understand and use standard algorithms for addition and subtraction of multi-digit numbers
 - 3.2 understand and use standard algorithms for multiplying a multi-digit number by a two digit number and long division for dividing a multi-digit number by a one digit number; use relationships between them to simplify computations and to check results
 - 3.3 solve problems involving multiplication of multi-digit numbers by two-digit numbers
 - 3.4 solve problems involving division of multi-digit numbers by one-digit numbers
- 4.0 Students know how to factor small whole numbers.
- 4.1 understand that many whole numbers can be factored in different ways and that such numbers are called composite numbers (e.g., $12 = 4 \times 3 = 2 \times 6 = 2 \times 2 \times 3$)
 - 4.2 know that numbers such as 2, 3, 5, 7, 11 do not have any factors except 1 and themselves, and that such numbers are called prime numbers

ALGEBRA AND FUNCTIONS

- 1.0 Students use and interpret variables, mathematical symbols and properties to write and simplify expressions and sentences.
- 1.1 use letters, boxes, or other symbols to stand for any number in simple expressions or equations (e.g., demonstrate understanding and use-of a variable)
 - 1.2 interpret and evaluate mathematical expressions that use parentheses
 - 1.3 use parentheses to indicate which operation to perform first when writing expressions containing more than two terms and different operations
 - 1.4 use and interpret formulas (e.g., Area = length times width or $A = lw$) to answer questions about quantities and their relationships
 - 1.5 understand that an equation such as $y = 3x + 5$ is a prescription for determining a second number when a first number is given
- 2.0 Students know how to manipulate equations.
- 2.1 know and understand that equals-added to equals are equal (e.g., if $2 + 1 = 3$, then

$$2 + 1 + \underline{5} = 3 + \underline{5})$$

- 2.2 know and understand that equals multiplied by equals are equal (e.g., if $3 \times 2 = 6$, then $3 \times 2 \times \underline{5} = 6 \times \underline{5}$)

MEASUREMENT AND GEOMETRY

- 1.0 Students understand perimeter and area.
- 1.1 measure the area of rectangular shapes using appropriate units (square centimeters, square meters, square kilometers, square inches, square yards, square miles)
 - 1.2 recognize that rectangles having the same area can have different perimeters
 - 1.3 understand that the same number can be the perimeter of different rectangles, each having a different area
 - 1.4 understand and use formulas to solve problems involving perimeters and areas of rectangles and squares; use these formulas to find the areas of more complex figures by dividing them into parts with these basic shapes
- 2.0 Students use two-dimensional coordinate grids to represent points and graph lines and simple figures.
- 2.1 draw the points corresponding to linear relationships on graph paper (e.g., draw the first ten points for the equation $y = 3x$ and connect them using a straight line)
 - 2.2 understand that the length of a horizontal line segment equals the difference of the x-coordinates
 - 2.3 understand that the length of a vertical line segment equals the difference of the y-coordinates
- 3.0 Students demonstrate understanding of plane and solid geometric objects and use this knowledge to show relationships and solve problems.
- 3.1 identify lines that are parallel and perpendicular
 - 3.2 identify the radius and diameter of a circle
 - 3.3 identify congruent and similar figures
 - 3.4 identify figures that have bilateral and rotational symmetry
 - 3.5 know the definitions of right angle, acute angle and obtuse angle
 - 3.6 understand that 90, 180, 270, and 360 degrees are associated with $1/4$, $1/2$, $3/4$ and full turns respectively
 - 3.7 visualize, describe and represent geometric solids (e.g., prisms, pyramids, etc.) in terms of the number and shape of faces, edges and vertices; interpret two-dimensional representations of three-

- dimensional objects; and draw patterns (of faces) for a solid that when folded will make a model of the solid
- 3.8 know the definitions of different triangles (e.g., equilateral, isosceles, scalene) and identify their features
 - 3.9 know the definition of different quadrilaterals (e.g., rhombus, square, rectangle, parallelogram, trapezoid)

STATISTICS, DATA ANALYSIS and PROBABILITY

- 1.0 Students organize, represent and interpret numerical and categorical data, and clearly communicate their findings.
 - 1.1 formulate survey questions, systematically collect and represent data on line plots, coordinate graphs, tables, and charts
 - 1.2 identify the mode(s) for sets of categorical data, and the mean, median, mode(s), range, and any apparent outliers for numerical data sets
 - 1.3 interpret one- and two-variable data graphs to answer questions about a situation
- 2.0 Students make predictions for simple probability situations.
 - 2.1 represent all possible outcomes for a simple probability situation in an organized way (e.g., tables, grids, tree diagrams)
 - 2.2 express outcomes of experimental probability situations verbally and numerically (e.g., 3 out of 4; $\frac{3}{4}$)

MATHEMATICAL REASONING

- 1.0 Students make decisions about how to approach problems.
 - 1.1 analyze problems by identifying relationships, discriminating relevant from irrelevant information, sequencing and prioritizing information, and observing patterns
 - 1.2 determine when and how to break a problem into simpler parts
- 2.0 Students use strategies, skills and concepts in finding solutions.
 - 2.1 use estimation to verify the reasonableness of calculated results
 - 2.2 apply strategies and results from simpler problems to more complex problems
 - 2.3 use a variety of methods such as words, numbers, symbols, charts, graphs, tables, diagrams and models to explain mathematical reasoning

- 2.4 express the solution clearly and logically using appropriate mathematical notation, terms, and clear language, and support solutions with evidence, in both verbal and symbolic work
- 2.5 indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy
- 2.6 make precise calculations and check the validity of the results from the context of the problem
- 3.0 Students move beyond a particular problem by generalizing to other situations.
 - 3.1 evaluate the reasonableness of the solution in the context of the original situation
 - 3.2 note method of deriving the solution and demonstrate conceptual understanding of the derivation by solving similar problems
 - 3.3 develop generalizations of the results obtained and extend them to other circumstances

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Mathematics Content Standards

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GRADE 5

By the end of fifth grade, students increase their facility with the four basic arithmetic operations applied to positive and negative numbers, fractions and decimals. They know and use common measuring units to determine length and area. They know and use formulas to determine the volume of simple geometric figures. Students know the concept of angle measurement and use a protractor and compass in solving problems. They use grids, tables, graphs, and charts to record and analyze data.

NUMBER SENSE

- 1.0 Students compute with very large and very small numbers, positive and negative numbers, decimals and fractions and understand the relationship between decimals, fractions and percents. They understand the relative magnitude of numbers.
 - 1.1 estimate, round, and manipulate very large (e.g., millions) and very small (e.g., thousandths) numbers
 - 1.2 interpret percents as part of a hundred and find and explain decimal and percent equivalents for common fractions
 - 1.3 compute a given percent of a whole number
 - 1.4 understand and compute positive integer powers of non-negative integers; compute examples as repeated multiplication
 - 1.5 determine the prime factors of all numbers through 50 and write numbers as the product of their prime factors using exponents to show multiples of a factor (e.g., $24 = 2 \times 2 \times 2 \times 3 = 2^3 \times 3$)
 - 1.6 identify and represent positive and negative integers, decimals, fractions and mixed numbers on a number line
- 2.0 Students perform calculations and solve problems involving addition, subtraction and simple multiplication and division of fractions and decimals.
 - 2.1 add, subtract, multiply and divide with decimals and negative numbers and verify the reasonableness of the results
 - 2.2 demonstrate proficiency with division, including division with positive decimals and long division with multiple digit divisors

- 2.3 solve simple problems including concrete situations involving the addition and subtraction of fractions and mixed numbers (like and unlike denominators of 20 or less) and express answers in simplest form
- 2.4 understand the concept of multiplication and division of fractions
- 2.5 compute and perform simple multiplication and division of fractions and apply these procedures to solving problems

ALGEBRA AND FUNCTIONS

1.0 Students use variables in simple expressions, compute the value of the expression for specific values of the variable, and plot and interpret the results.

- 1.1 use information taken from a graph or equation to answer questions about a problem situation
- 1.2 use a letter to represent an unknown number; write and evaluate simple algebraic expressions in one variable by substitution
- 1.3 know and use the distributive property in equations and expressions with variables
- 1.4 identify and graph ordered pairs in the four quadrants of the coordinate plane
- 1.5 solve problems involving linear functions with integer values, write the equation, and graph the resulting ordered pairs of integers on a grid e.g., $y = x + 1$;

x	y
1	2
2	3
3	4

MEASUREMENT AND GEOMETRY

- 1.0 Students understand and compute volumes and areas of simple objects.
 - 1.1 derive and use the formula for the area of right triangles and of parallelograms by comparing with the area of rectangles (i.e., two of the same triangles make a rectangle with twice the area; a parallelogram is compared to a rectangle with the same area found by cutting and pasting a right triangle)
 - 1.2 construct cube and rectangular boxes from two-dimensional patterns and use this to compute the surface area for these objects
 - 1.3 understand the concept of volume and use the appropriate units in common measuring systems (cubic centimeters, cubic meters, and cubic inches) to compute the volume of rectangular solids
 - 1.4 differentiate between and use appropriate units of measures for two- and three-dimensional objects (perimeter, area and volume)

- 2.0 Students identify, describe, draw and classify properties of, and relationships between, plane and solid geometric figures.
 - 2.1 measure, identify and draw angles, perpendicular and parallel lines, rectangles and triangles, using appropriate tools (e.g., straight edge, ruler, compass, protractor and drawing software)
 - 2.2 know that the sum of the angles of any triangle is 180° and the sum of the angles of any quadrilateral is 360° and use this information to solve problems
 - 2.3 visualize and draw two-dimensional views of three-dimensional objects made from rectangular solids

STATISTICS, DATA ANALYSIS and PROBABILITY

- 1.0 Students display, analyze, compare and interpret different data sets, including data sets that are not the same size.
 - 1.1 know the concepts of mean, median, and mode; compute and compare them in simple examples and notice that they can differ
 - 1.2 organize and display single-variable data in appropriate graphs and representations (e.g., histograms, circle graphs) and explain which types of graphs are appropriate for different kinds of data sets
 - 1.3 use fractions and percentages to compare data sets of different size
 - 1.4 identify ordered pairs of data from a graph and interpret the meaning of the data in terms of the situation depicted by the graph
 - 1.5 know how to write ordered pairs correctly, (e.g., (x, y))

MATHEMATICAL REASONING

- 1.0 Students make decisions about how to approach problems.
 - 1.1 analyze problems by identifying relationships, discriminating relevant from irrelevant information, sequencing and prioritizing and observing patterns
 - 1.2 determine when and how to break a problem into simpler parts
- 2.0 Students use strategies, skills and concepts in finding solutions.
 - 2.1 use estimation to verify the reasonableness of calculated results
 - 2.2 apply strategies and results from simpler problems to more complex problems
 - 2.3 use a variety of methods such as words, numbers, symbols, charts, graphs, tables, diagrams and models to explain mathematical reasoning

- 2.4 express the solution clearly and logically using appropriate mathematical notation,-terms, and clear language, and support solutions with evidence, in both verbal and symbolic work
- 2.5 indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy
- 2.6 make precise calculations and check the validity of the results from the context of the problem
- 3.0 Students move beyond a particular problem by generalizing to other situations.
 - 3.1 evaluate the reasonableness of the solution in the context of the original situation
 - 3.2 note method of deriving the solution and demonstrate conceptual understanding of the derivation by solving similar problems
 - 3.3 develop generalizations of the results obtained and extend them to other circumstances

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

GRADE 6

By the end of sixth grade, students have mastered the four arithmetic operations with positive and negative numbers, whole numbers, fractions and decimals. They accurately compute and solve problems. They apply their knowledge to statistics and probability. Students understand the concept of and how to calculate the range, mean, median and mode of data sets. They analyze data and sampling processes for possible bias and misleading conclusions, and they use addition and multiplication of fractions routinely to calculate probabilities for compound events. Students conceptually understand and work with ratios and proportions. They compute percentages (e.g., tax, tips, interest). Students know about Π and the formulas for the circumference and area of a circle. They use letters for numbers in formulas involving geometric shapes and in representing an unknown part of a ratio. They solve one-step linear equations.

NUMBER SENSE

- 1.0 Students compare and order fractions, decimals, and mixed numbers. They solve problems involving fractions, ratios, proportions, and percentages.
 - 1.1 compare and order positive and negative fractions, decimals, and mixed numbers and place them on a number line
 - 1.2 interpret and use ratios in different contexts (e.g., batting averages, miles per hour) to show the relative sizes of two quantities using appropriate notations (a/b , a to b , $a:b$)
 - 1.3 use proportions to solve problems (e.g., determine the value of N if $4/7 = N/21$, find the length of a side of a polygon similar to a known polygon). Use cross-multiplication as a method for solving such problems
 - 1.4 calculate given percentages of quantities and solve problems involving discounts at sales, interest earned and tips
- 2.0 Students calculate and solve problems involving addition, subtraction, multiplication and division of rational numbers.
 - 2.1 solve problems involving addition, subtraction, multiplication and division of fractions and explain why a particular operation was used for a given situation
 - 2.2 explain the meaning of multiplication and division of fractions and perform the calculations (e.g., $5/8 \div 15/16 = 5/8 \times 16/15 = 2/3$)
 - 2.3 solve addition, subtraction, multiplication and division problems including those arising in concrete situations that use positive and negative numbers and combinations of these operations

- 2.4 determine the least common multiple and greatest common factor of whole numbers. Use them to solve problems with fractions (e.g., to find a common denominator in order to add two fractions or to find the simplest form for a fraction)

ALGEBRA AND FUNCTIONS

- 1.0 Students write verbal expressions and sentences as algebraic expressions and equations; evaluate algebraic expressions, solve simple linear equations, and graph and interpret results.
 - 1.1 write and solve one-step linear equations in one variable
 - 1.2 write and evaluate an algebraic expression for a given situation using up to three variables
 - 1.3 apply algebraic order of operations and the commutative, associative and distributive properties to evaluate expressions and justify each step in the process
 - 1.4 solve problems using correct order of operations manually and by using a scientific calculator; know and understand why a scientific calculator calculates an answer differently from a non-scientific calculator
- 2.0 Students analyze and use tables, graphs and rules to solve problems involving rates and proportions.
 - 2.1 convert from one unit of measurement to another (e.g., from feet to miles, from centimeters to inches)
 - 2.2 demonstrate understanding that rate is a measure of one quantity per unit value of another quantity
 - 2.3 solve problems involving rates, average speed, distance and time
- 3.0 Students investigate geometric patterns and describe them algebraically.
 - 3.1 use variables in expressions describing geometric quantities which give the perimeter of a rectangle, area of a triangle, and circumference of a circle (e.g., $P = 2w + 2l$, $A = 1/2 bh$, $C = \Pi d$)
 - 3.2 express simple relationships arising from geometry in symbolic form

MEASUREMENT AND GEOMETRY

- 1.0 Students deepen their understanding of measurement of plane and solid shapes and use this understanding to solve problems.
 - 1.1 understand the concept of a constant number like Π ; know the formulas for the circumference and area of a circle
 - 1.2 know common estimates of Π (e.g., 3.14 or $22/7$) and use these values to estimate and calculate the circumference and the area of circles; compare with actual measurements

1.3 (area of base x height); compare and explain the similarity between these formulas and the formula for the volume of a rectangular solid

2.0 Students identify and describe the properties of two-dimensional figures.

2.1 identify angles as vertical, adjacent, complementary or supplementary and provide descriptions of these terms

2.2 use the properties of complementary and supplementary angles and of the angles of a triangle to solve problems involving an unknown angle

2.3 draw quadrilaterals and triangles given information about them (e.g., a quadrilateral having equal sides but no right angles, a right isosceles triangle)

2.4 describe the properties of similar figures

STATISTICS, DATA ANALYSIS and PROBABILITY

1.0 Students compute and analyze statistical measurement for data sets.

1.1 compute the range, mean, median and mode of data sets

1.2 determine the range and an appropriate scale for a data set in order to construct or graph representing that data

1.3 understand how additional data added to data sets can affect these computations of measures of central tendency

1.4 understand how the inclusion or exclusion of outliers affect measures of central tendency

1.5 know why a specific measure of central tendency (mean, median, mode) provides the most useful information in a given context

2.0 Students use data samples of a population and describe the characteristics and limitations of the samples.

2.1 compare different samples from a population with the data from the entire population and identify when it makes sense to use a sample

2.2 identify different ways of selecting a sample (e.g., convenience sampling, those who respond to a survey, random sampling) and which makes a sample more representative for a population

2.3 analyze data displays and explain how the way the question was asked might have influenced the results obtained, and/or how the way the results were displayed might have influenced the conclusions reached

2.4 identify data that represent sampling and explain why the sample (and the display) may be biased

- 2.5 identify claims based on statistical data and, in simple cases, evaluate the validity of the claims
- 3.0 Students determine theoretical and experimental probabilities and use these to make predictions about events.
 - 3.1 represent all possible outcomes for compound events in an organized way (e.g., tables, grids, tree diagrams) and express the theoretical probability of each outcome
 - 3.2 use data to estimate the probability for future events (e.g., batting averages or number of accidents per mile driven)
 - 3.3 represent probabilities as ratios, proportions, and decimals between 0 and 1, and percents between 0 and 100 and check that probabilities computed are reasonable; know how this is related to the probability of an event not occurring
 - 3.4 understand that the probability of either of two disjoint events occurring is the sum of the two individual probabilities and that the probability of one event following another, in independent trials, is the product of the two probabilities
 - 3.5 understand the difference between independent and dependent events and how this affects the results for specific probability situations

MATHEMATICAL REASONING

- 1.0 Students make decisions about how to approach problems.
 - 1.1 analyze problems by identifying relationships, discriminating relevant from irrelevant information, identifying missing information, sequencing and prioritizing information and observing patterns
 - 1.2 formulate and justify mathematical conjectures based upon a general description of the mathematical question or problem posed
 - 1.3 determine when and how to break a problem into simpler parts
- 2.0 Students use strategies, skills and concepts in finding solutions.
 - 2.1 use estimation to verify the reasonableness of calculated results
 - 2.2 apply strategies and results from simpler problems to more complex problems
 - 2.3 estimate unknown quantities graphically and solve-using logical reasoning, arithmetic and algebraic techniques
 - 2.4 use a variety of methods such as words, numbers, symbols, charts, graphs, tables, diagrams and models to explain mathematical reasoning

- 2.5 express the solution clearly and logically using appropriate mathematical notation, terms, and clear language, and support solutions with evidence in both verbal and symbolic work
- 2.6 indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy
- 2.7 make precise calculations and check the validity of the results from the context of the problem
- 3.0 Students move beyond a particular problem by generalizing to other situations.
 - 3.1 evaluate the reasonableness of the solution in the context of the original situation
 - 3.2 note method of deriving the solution and demonstrate conceptual understanding of the derivation by solving similar problems
 - 3.3 develop generalizations of the results obtained and the strategies used and extend them to new problem situations

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

GRADE 7

By the end of seventh grade students are adept at manipulating numbers and equations and understand the general principles at work. They understand and use factoring of numerators and denominators and properties of exponents. They know the Pythagorean Theorem and solve problems where they compute the length of an unknown side. Students know how to compute the surface area and volume of basic 3-D objects and understand how they change under a change in scale. Students convert between different units of measurement. They know and use different representations of fractional numbers (fractions, decimals, and percent) and are proficient at changing from one to another. They increase their facility with ratio and proportion and compute percentages of increase and decrease and simple compound interest. They graph linear functions and understand the idea of slope and its relation to ratio.

NUMBER SENSE

- 1.0 Students know the properties of and compute with rational numbers expressed in a variety of forms.
 - 1.1 read, write and compare rational numbers in scientific notation (positive and negative powers of 10), approximate numbers using scientific notation
 - 1.2 add, subtract, multiply and divide rational numbers (integers, fractions and decimals) and take rational numbers to whole number powers
 - 1.3 convert fractions to decimals and percents and use these representations in estimation, computation and applications
 - 1.4 differentiate between rational and irrational numbers
 - 1.5 know that every fraction is either a terminating or repeating decimal and be able to convert terminating decimals into simplified fractions
 - 1.6 calculate percent of increases and decreases of a quantity
 - 1.7 solve problems that involve discounts, markups, commissions, profit and simple compound interest
- 2.0 Students use exponents, powers, and roots and use exponents in working with fractions.
 - 2.1 understand negative whole number exponents; multiply and divide expressions involving exponents with a common base
 - 2.2 add and subtract fractions using factoring to find common denominators

- 2.3 multiply, divide, and simplify fractions using exponent rules
- 2.4 use the inverse relationship between raising to a power and root extraction for perfect square integers; and, for integers that are not square, determine without a calculator, the two integers between which its square root lies, and explain why
- 2.5 understand the meaning of the absolute value of a number, interpret it as the distance of the number from zero on a number line and determine the absolute value of real numbers

ALGEBRA AND FUNCTIONS

- 1.0 Students express quantitative relationships using algebraic terminology, expressions, equations, inequalities and their graphs.
 - 1.1 use variables and appropriate operations to write an expression, equation, inequality, or system of equations or inequalities that represent a verbal description (e.g., three less than a number, half as large as area A)
 - 1.2 use order of operations correctly to evaluate algebraic expressions such as $3(2x + 5)^2$
 - 1.3 simplify numerical expressions by applying properties of rational numbers (identity, inverse, distributive, associative, commutative), and justify the process used
 - 1.4 use algebraic terminology correctly (e.g., variable, equation, term, coefficient, inequality, expression, constant)
 - 1.5 represent quantitative relationships graphically and interpret the meaning of a specific part of a graph in terms of the situation represented by the graph
- 2.0 Students interpret and evaluate expressions involving integer powers and simple roots.
 - 2.1 interpret positive whole number powers as repeated multiplication and negative whole numbers as repeated division or multiplication by the multiplicative inverse
 - 2.2 simplify and evaluate expressions that include exponents
 - 2.3 multiply and divide monomials
 - 2.4 extend the process of taking powers and extracting roots to monomials when the extracted root results in a monomial with an integer exponent
- 3.0 Students graph and interpret linear and some non-linear functions.
 - 3.1 graph functions of the form $y = nx^2$ and $y = nx^3$ and use in solving problems
 - 3.2 plot the values from the volumes of a 3-D shape for various values of its edge

- 3.3 graph linear functions, noting that the vertical change (change in y-value) per unit horizontal change (change in x-value) is constant and know that the ratio ("rise over run") is called the slope of a graph
 - 3.4 plot values of the quantities whose ratio is constant (cost vs. number of an item, feet vs. inches, circumference vs. diameter of a circle); fit a line to the plot and understand that the slope of the line equals the quantities
- 4.0 Students solve simple linear equations and inequalities over the rational numbers.
- 4.1 solve two-step linear equations and inequalities in one variable over the rational numbers, interpret the solution(s) in terms of the context from which they arose and verify the reasonableness of the results
 - 4.2 solve multi-step problems involving rate, average speed, distance and time, or direct variation

MEASUREMENT AND GEOMETRY

- 1.0 Students choose appropriate units of measure and use ratios to convert within and between measurement systems to solve problems.
- 1.1 compare weights, capacities, geometric measures, times and temperatures within and between measurement systems (e.g., miles per hour and feet per second, cubic inches to cubic centimeters)
 - 1.2 construct and read scale drawings and models
 - 1.3 use measures expressed as rates (e.g., speed, density) and measures expressed as products (e.g., person-days) to solve problems, checking units of the solutions; and use dimensional analysis to check the reasonableness of the answer
- 2.0 Students compute the perimeter, area and volume of common geometric objects and use these to find measures of less common objects and know how perimeter, area, and volume are affected under changes of scale.
- 2.1 routinely use formulas for finding the perimeter and area of basic two-dimensional figures and for the surface area and volume of basic three-dimensional figures, including rectangles, parallelograms, trapezoids, squares, triangles, circles, prisms, and circular cylinders
 - 2.2 estimate and compute the area of more complex or irregular two- and three-dimensional figures by breaking them up into more basic geometric objects
 - 2.3 compute the length of the perimeter, the surface area of the faces, and the volume of a 3-D object built from rectangular solids; understand that when the lengths of all dimensions are multiplied by a scale factor, the surface area is multiplied by the square of the scale factor and the volume is multiplied by the cube of the scale factor

- 2.4 relate the changes in measurement under change of scale to the units used (e.g., square inches, cubic feet) and to conversions between units (1 square foot = 12^2 square inches, 1 cubic inch = 2.54^3 cubic centimeters)
- 3.0 Students know the Pythagorean Theorem and deepen their understanding of plane and solid geometric shapes by constructing figures that meet given conditions and by identifying attributes of figures.
 - 3.1 identify and construct basic elements of geometric figures, (e.g., altitudes, midpoints, diagonals, angle bisectors and perpendicular bisectors; and central angles, radii, diameters and chords of circles) using compass and straight-edge
 - 3.2 understand and use coordinate graphs to plot simple figures, determine lengths and areas related to them, and determine their image under translations and reflections
 - 3.3 know and understand the Pythagorean Theorem and use it to find the length of the missing side of a right triangle and lengths of other line segments, and, in some situations, empirically verify the Pythagorean Theorem by direct measurement
 - 3.4 demonstrate an understanding of when two geometric figures are congruent and what congruence means about the relationships between the sides and angles of the two figures
 - 3.5 construct two-dimensional patterns for three-dimensional models such as cylinders, prisms and cones
 - 3.6 identify elements of three-dimensional geometric objects (e.g., diagonals of rectangular solids) and how two or more objects are related in space (e.g., skew lines, the possible ways three planes could intersect)

STATISTICS, DATA ANALYSIS AND PROBABILITY

- 1.0 Students collect, organize and represent data sets that have one or more variables and identify relationships among variables within a data set both manually and by using an electronic spreadsheet program.
 - 1.1 know various forms of display for data sets, including a stem-and-leaf plot or box-and-whisker plot; use to display a single set of data or compare two sets of data
 - 1.2 represent two numerical variables on a scatter plot and informally describe how the data points are distributed and whether there is an apparent relationship between the two variables (e.g., time spent on homework and grade level)
 - 1.3 understand the meaning of and be able to compute the minimum, the lower quartile, the median, the upper quartile and the maximum of a data set

MATHEMATICAL REASONING

- 1.0 Students make decisions about how to approach problems.

- 1.1 analyze problems by identifying relationships, discriminating relevant from irrelevant information, identifying missing information, sequencing and prioritizing information, and observing patterns
- 1.2 formulate and justify mathematical conjectures based upon a general description of the mathematical question or problem posed
- 1.3 determine when and how to break a problem into simpler parts
- 2.0 Students use strategies, skills and concepts in finding solutions.
 - 2.1 use estimation to verify the reasonableness of calculated results
 - 2.2 apply strategies and results from simpler problems to more complex problems
 - 2.3 estimate unknown quantities graphically and solve using logical reasoning,-arithmetic and algebraic techniques
 - 2.4 make and test conjectures using both inductive and deductive reasoning
 - 2.5 use a variety of methods such as words, numbers, symbols, charts, graphs, tables, diagrams and models to explain mathematical reasoning
 - 2.6 express the solution clearly and logically using appropriate mathematical notation, terms, and clear language, and support solutions with evidence, in both verbal and symbolic work
 - 2.7 indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy
 - 2.8 make precise calculations and check the validity of the results from the context of the problem
- 3.0 Students determine a solution is complete and move beyond a particular problem by generalizing to other situations.
 - 3.1 evaluate the reasonableness of the solution in the context of the original situation
 - 3.2 note method of deriving the solution and demonstrate conceptual understanding of the derivation by solving similar problems
 - 3.3 develop generalizations of the results obtained and the strategies used and extend them to new problem situations

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

INTRODUCTION TO GRADES 8 THROUGH 12

The standards for grades 8 through 12 are organized differently than those for kindergarten through grade 7. Strands are not used for organizational purposes because, unlike in the earlier grades, in grades 8 through 12 the mathematics studied naturally falls under discipline headings: Algebra, Geometry, etc. Many schools teach this material in traditional courses, while others teach this material in an integrated fashion. In order to provide local educational agencies and teachers with flexibility, the grades 8 through 12 standards do not mandate a particular discipline to be initiated and completed in a single grade. Nevertheless, however it is taught, the core content of these subjects must be covered and all academic standards for achievement must be the same.

What follows are standards: Algebra 1, Geometry, Algebra 2, Trigonometry, Mathematical Analysis, Linear Algebra, Statistics, Advanced Placement Statistics, and Calculus. It is recognized that many of the more advanced subjects are not taught in every middle or high school. Moreover, schools and districts have different ways of combining the subject matter in these various disciplines. For example, many schools combine some Trigonometry, Mathematical Analysis, and Linear Algebra to form a pre-Calculus course. Some districts prefer offering Trigonometry content with Algebra 2.

The table below reflects typical grade level groupings of these disciplines in both integrated and traditional curricula.

Many other combinations of these advanced subjects into courses are possible. What is described here are standards for the academic content by discipline; it is not an endorsement of a particular choice of structure for courses or a particular method of teaching the mathematical content.

When students delve deeply into mathematics they gain not only conceptual understanding of mathematical principles but they also gain knowledge of and experience with pure reasoning. One of the most important goals of mathematics is to teach students logical reasoning. The logical reasoning inherent to the study of mathematics allows for applications to a broad range of situations where answers to practical problems can be found with accuracy.

By the eighth grade, students' mathematical sensitivity should be sharpened. Students need to start perceiving logical subtleties and appreciate the need for sound mathematical arguments before making conclusions. As students progress in the study of mathematics, they learn to distinguish between inductive and deductive reasoning; understand the meaning of logical implication; test general assertions; realize that one counterexample is enough to show that a general assertion is false; conceptually understand that the truth of a general assertion in a few cases does not allow the conclusion that it is true in all cases; distinguish between something being proven and a mere plausibility argument; and identify logical errors in chains of reasoning. Mathematical reasoning and conceptual understanding are not separate from content; they are intrinsic to the mathematical discipline students master at these more advanced levels.

Discipline/Grade	8	9	10	11	12
Algebra 1					
Geometry					
Algebra 2					
Prob and Stats					
Trigonometry					
Linear Algebra					
Math Analysis					
Prob and Stats AP					
Calculus AP					

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

ALGEBRA 1

Symbolic reasoning and calculations with symbols are central in algebra. In the study of algebra, a student develops an understanding of the symbolic language of mathematics and the sciences. In addition, algebraic skills and concepts are developed and used in a wide variety of problem solving situations.

- 1.0 Students identify and use the arithmetic properties of subsets of integers, rational, irrational and real numbers. This includes closure properties for the four basic arithmetic operations where applicable.
- 2.0 Students use properties of numbers to demonstrate that algebraic assertions are true or false.
- 3.0 Students understand and use such operations as taking the opposite, reciprocal, raising to a power, and taking a root. This includes the understanding and use of the rules of exponents.
- 4.0 Students simplify expressions prior to solving linear equations and inequalities in one variable such as $3(2x - 5) + 4(x - 2) = 12$.
- 5.0 Students solve multi-step problems, including word problems, involving linear equations and linear inequalities in one variable, with justification of each step.
- 6.0 Students solve equations and inequalities involving absolute values.
- 7.0 Students verify that a point lies on a line given an equation of the line.
- 8.0 Students graph a linear equation, compute the slope and determine the x and y intercepts (e.g., graph $2x + 6y = 4$). They sketch the region defined by a linear inequality (e.g., sketch the region defined by $2x + 6y > 4$).
- 9.0 Students derive linear equations using the point-slope formula.
- 10.0 Students understand the concepts of parallel and perpendicular lines and how their slopes are related. Students find the equation of a line perpendicular to a given line that passes through a given point.
- 11.0 Students solve a system of two linear equations in two variables algebraically and interpret the answer graphically. Students use this to solve a system of two linear inequalities in two variables and to sketch the solution sets.
- 12.0 Students add, subtract, multiply and divide monomials and polynomials and solve multi-step problems using these techniques.

- 13.0 Students apply basic factoring techniques to second and simple third degree polynomials. These techniques include finding a common factor, recognizing the difference of two squares, and recognizing perfect squares of binomials.
- 14.0 Students simplify fractions with polynomials in the numerator and denominator by factoring both and reducing to lowest terms.
- 15.0 Students add, subtract, multiply, and divide rational expressions and functions. Students solve both computationally and conceptually challenging problems using these techniques.
- 16.0 Students solve a quadratic equation by factoring or completing the square.
- 17.0 Students apply algebraic techniques to rate problems, work problems, and percent mixture problems.
- 18.0 Students understand the concepts of a relation and a function, determine whether a given relation defines a function, and give pertinent information about given relations and functions.
- 19.0 Students determine the domain of independent variables, and range of dependent variables defined by a graph, a set of ordered pairs, or symbolic expression.
- 20.0 Students determine whether a relation defined by a graph, a set of ordered pairs, or symbolic expression is a function and justify the conclusion.
- 21.0 Students simplify radical expressions involving the four basic operations.
- 22.0 Students know the quadratic formula and are familiar with its proof by completing the square.
- 23.0 Students use the quadratic formula to find the roots of a second degree polynomial and to solve quadratic equations.
- 24.0 Students graph quadratic functions and know that their roots are the x-intercepts.
- 25.0 Students use the quadratic formula and/or factoring techniques to determine whether the graph of a quadratic function will intersect the x-axis in zero, one, or two points.
- 26.0 Students apply quadratic equations to physical problems such as the motion of an object under the force of gravity.
- 27.0 Students know and use simple aspects of a logical argument.
- 27.1 Students explain the difference between inductive and deductive reasoning and identify and provide examples of each.
- 27.2 Students identify the hypothesis and conclusion in logical deduction.
- 27.3 Students use counterexamples to show that an assertion is false and recognize that a single counterexample is sufficient to refute an assertion

- 28.0 Students use properties of the number system to judge the validity of results, to justify each step of a procedure and to prove or disprove statements.
- 28.1 Students use properties of numbers to construct simple valid direct and indirect arguments for claimed assertions, or to formulate counterexamples to claimed assertions.
- 28.2 Students judge the validity of an argument based on whether the properties of the real number system and order of operations have been applied correctly at each step.
- 28.3 Students determine if a specific algebraic statement involving linear, quadratic or absolute value equations or inequalities is true sometimes, always, or never.

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

GEOMETRY

The geometric skills and concepts developed in this discipline are useful to all students. Aside from these skills and concepts, students will develop their ability to construct formal logical arguments and proofs in geometric settings and problems.

- 1.0 Students identify and give examples of defined terms, undefined terms, axioms/postulates, theorems, and inductive and deductive reasoning.
- 2.0 Students perform basic constructions with straightedge and compass such as angle bisectors, perpendicular bisectors, and the line parallel to a given line through a point off the line.
- 3.0 Students construct and judge the validity of a logical argument. This includes giving counterexamples to disprove a statement.
- 4.0 Students write formal and informal geometric proofs, including proof by contradiction.
- 5.0 Students prove basic theorems involving congruence and similarity.
- 6.0 Students prove triangles are congruent or similar and use the concept of corresponding parts of congruent triangles.
- 7.0 Students know and use the Triangle Inequality Theorem.
- 8.0 Students use the properties of isosceles, equilateral, and scalene triangles.
- 9.0 Students find and use measures of sides, interior and exterior angles of triangles and polygons to classify figures and solve problems.
- 10.0 Students prove relationships between angles in polygons using properties of complementary, supplementary, vertical, and exterior angles.
- 11.0 Students prove and use theorems involving the properties of parallel lines, quadrilaterals, and circles.
- 12.0 Students prove and solve problems regarding relationships among chords, secants, tangents, inscribed angles, and inscribed and circumscribed polygons of circles.
- 13.0 Students know, derive, and use formulas to solve problems involving perimeter, circumference, area, volume, lateral area, and surface area of common geometric figures.

- 14.0 Students compute the area of polygons including rectangles, scalene triangles, equilateral triangles, rhombi, parallelograms, and trapezoids.
- 15.0 Students compute the volume and surface area of prisms, pyramids, cylinders, cones, and spheres.
- 16.0 Students determine how changes in dimensions affect the perimeter, area, and volume of common geometric figures and solids.
- 17.0 Students prove the Pythagorean Theorem.
- 18.0 Students use the Pythagorean Theorem to find missing lengths of sides of right triangles.
- 19.0 Students prove theorems using coordinate geometry, including the midpoint of a line segment, the distance formula, and various forms of equations of lines and circles.
- 20.0 Students know the effect of rigid motions on figures in the coordinate plane and space, including rotations, translations, and reflections.
- 21.0 Students know the definitions of the basic trigonometric functions defined by the angles of a right triangle. They know and use elementary relationships between them, (e.g., $\tan x = \sin x / \cos x$, $\sin^2 x + \cos^2 x = 1$).
- 22.0 Students use trigonometric functions to solve for an unknown length of a side of a right triangle, given an angle and a length of a side.
- 23.0 Students know and use angle and side relationships in problems with special right triangles such as 30-60-90 and 45-45-90 triangles.

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

ALGEBRA 2

This discipline complements and expands the mathematical content and concepts of Algebra 1 and Geometry. Students who master Algebra 2 will gain experience with algebraic solutions of problems in various content areas, including the solution of systems of quadratic equations, logarithmic and exponential functions, the binomial theorem, and the complex number system.

- 1.0 Students solve problems involving functional concepts such as composition, inverse, and arithmetic operations on functions.
- 2.0 Students use properties from number systems to justify steps in combining and simplifying functions.
- 3.0 Students solve equations and inequalities involving absolute value.
- 4.0 Students solve systems of linear equations and inequalities (in two or three variables) simultaneously, by substitution, graphically, or with matrices.
- 5.0 Students are adept at operations on polynomials, including long and synthetic division.
- 6.0 Students factor polynomials representing the difference of squares, perfect square trinomials, and the sum and difference of two cubes.
- 7.0 Students demonstrate knowledge of how real and complex numbers are related both arithmetically and graphically and plot complex numbers as points in a plane.
- 8.0 Students add, subtract, multiply, and divide complex numbers.
- 9.0 Students add, subtract, multiply, divide, simplify and evaluate rational expressions with monomial and polynomial denominators, and simplify complicated fractions including fractions with negative exponents in the denominator.
- 10.0 Students solve and graph quadratic equations by factoring, completing the square, or using the quadratic formula. Students apply these techniques in solving word problems and also solve quadratic equations in the complex number system.
- 11.0 Students demonstrate and explain the effect changing a coefficient has on the graph of quadratic functions. Students determine how the graph of a parabola changes as a , b , and c vary in the equation $y = a(x - b)^2 + c$.
- 12.0 Students graph quadratic functions and determine the maxima, minima, and zeros of the function.

- 13.0 Students prove simple laws of logarithms.
- 13.1 understand the inverse relationship between exponents and logarithms, and use this relationship to solve problems involving logarithms and exponents.
- 13.2 judge the validity of an argument based on whether the properties of real numbers, exponents, and logarithms have been applied correctly at each step.
- 14.0 Students know the laws of exponents, understand exponential functions, and use these functions in problems involving exponential growth and decay.
- 15.0 Students use the definition of logarithms and the product formula for logs to translate between logarithms in any bases.
- 16.0 Students understand and use the properties of logarithms to simplify logarithmic numeric expressions and identify their approximate values.
- 17.0 Students determine if a specific algebraic statement involving rational expressions, radical expressions, logarithmic or exponential functions, is sometimes true, always true, or never true.
- 18.0 Students demonstrate and explain how the geometry of the graph of a conic section (e.g., asymptotes, foci, eccentricity) depends on the coefficients of the quadratic equation representing it.
- 19.0 Given a quadratic equation of the form $ax^2 + by^2 + cx + dy + e = 0$, students can use the method of completing the square to put the equation into standard form and recognize whether its graph is a circle, ellipse, parabola, or hyperbola, and graph the equation.
- 20.0 Students use fundamental counting principles to compute combinations and permutations.
- 21.0 Students use combinations and permutations to compute probabilities.
- 22.0 Students know the Binomial Theorem and use it to expand binomial expressions that are raised to positive integer powers.
- 23.0 Students apply the method of mathematical induction to prove general statements about the positive integers.
- 24.0 Students find the general term and the sums of arithmetic series and both finite and infinite geometric series.
- 25.0 Students derive the summation formulas for arithmetic series and both finite and infinite geometric series.

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

TRIGONOMETRY

Trigonometry is a discipline that utilizes the techniques of both the algebra and geometry that students have previously learned. The trigonometric functions studied are defined geometrically, rather than in terms of algebraic equations. Facility with these functions as well as being able to prove basic identities regarding them is especially important for students intending to study calculus, more advanced mathematics, physics and other sciences, and engineering in college.

- 1.0 Students understand the notion of angle and how to measure it, both in degrees and radians. Students convert between degrees and radians.
- 2.0 Students know the definition of sine and cosine as y and x coordinates of points on the unit circle, and are familiar with the graphs of the sine and cosine functions.
- 3.0 Students know the identity $\cos^2(x) + \sin^2(x) = 1$.
 - 3.1 prove this identity is equivalent to the Pythagorean Theorem
 - 3.2 prove and simplify other trigonometric identities-using the identity $\cos^2(x) + \sin^2(x) = 1$ (e.g., use this identity to prove that $\sec^2(x) = \tan^2(x) + 1$).
- 4.0 Students graph functions of the form, $f(t) = a \sin(bt - c)$ and $f(t) = a \cos(bt - c)$, and interpret a and b in terms of amplitude, frequency, period, and phase shift.
- 5.0 Students know the definition of the tangent and cotangent functions and graph them.
- 6.0 Students know the definitions of the secant and cosecant functions and graph them.
- 7.0 Students know that the tangent of the angle a line makes with the x-axis is equal to the slope of the line.
- 8.0 Students know the definitions of the inverse trigonometric functions and graph the functions.
- 9.0 Students compute, without a calculator, the exact values of the trigonometric functions and the inverse trigonometric functions at various standard points.
- 10.0 Students demonstrate understanding of the addition formulas for sines and cosines and their proofs. Students use them to prove and/or simplify other trigonometric identities.
- 11.0 Students demonstrate understanding of half-angle and double-angle formulas for sines and cosines and use them to prove and/or simplify other trigonometric identities.

- 12.0 Students use trigonometry to determine unknown sides or angles in right triangles.
- 13.0 Students know the Law of Sines and the Law of Cosines and apply them to problems.
- 14.0 Students determine the area of a triangle given one angle and the two adjacent sides.
- 15.0 Students are familiar with polar coordinates and determine polar coordinates of a point given in rectangular coordinates, and vice versa.
- 16.0 Students represent equations given in rectangular coordinates in terms of polar coordinates.
- 17.0 Students are familiar with complex numbers, can represent a complex number in polar form, and know how to multiply complex numbers in polar form.
- 18.0 Students know De Moivre's Theorem and give n -th roots of a complex number given in polar form.
- 19.0 Students are adept at using trigonometry in a variety of applications and word problems.

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

MATHEMATICAL ANALYSIS

This discipline combines many of the trigonometric, geometric, and algebraic techniques needed in preparation of the study of Calculus and strengthens conceptual understanding and mathematical reasoning when solving problems. A functional point of view is emphasized and the most significant new concept is that of limits. Mathematical Analysis is combined with Trigonometry and Linear Algebra to make a year long pre-Calculus course.

- 1.0 Students are familiar with and can apply polar coordinates and vectors in the plane, translate between polar and rectangular coordinates, and interpret polar coordinates and vectors graphically.
- 2.0 Students are adept at the arithmetic of complex numbers, can use the trigonometric form of complex numbers, and understand that a function of a complex variable can be viewed as a function of two real variables. Students know the proof of De Moivre's Theorem.
- 3.0 Students prove various formulas using the technique of mathematical induction.
- 4.0 Students know of and apply the Fundamental Theorem of Algebra.
- 5.0 Students are familiar with conic sections, both analytically and geometrically.
 - 5.1 take a quadratic equation in two variables, put it in standard form by completing the square and using rotations and translations if necessary, determine what type of conic section the equation represents, and determine its geometric components (foci, asymptotes, etc.)
 - 5.2 take a geometric description of a conic and derive a quadratic equation representing it
- 6.0 Students find the roots and poles of a rational function, graph the function, and can locate its asymptotes.
- 7.0 Students demonstrate an understanding of functions and equations defined parametrically and can graph them.
- 8.0 Students are familiar with the concept of the limit of a sequence and the limit of a function as the independent variable approaches a number or infinity and determine if certain sequences converge or diverge.

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

LINEAR ALGEBRA

The goal of this discipline is to learn the techniques of matrix manipulation to solve systems of linear equations in any number of variables. Linear Algebra is combined with Trigonometry and Mathematical Analysis in Pre-Calculus.

- 1.0 Students solve simultaneous linear equations in any number of variables using Gauss-Jordan method.
- 2.0 Students interpret linear systems as coefficient matrices and the Gauss-Jordan method as row operations on the coefficient matrix.
- 3.0 Students reduce rectangular matrices to row echelon form.
- 4.0 Students perform addition on matrices and vectors.
- 5.0 Students perform matrix multiplication, multiply vectors by matrices and by scalars.
- 6.0 Students understand that linear systems are either inconsistent (no solutions), have exactly one solution, or have infinitely many solutions.
- 7.0 Students understand the geometric interpretation of vectors and vector addition using parallelograms for vectors in the plane and in three-dimensional space.
- 8.0 Students interpret the solution sets of systems of equations geometrically.
- 9.0 Students understand the concept of an inverse \mathbf{A}^{-1} of a square matrix and apply it to solve systems of linear equations.
- 10.0 Students compute the determinants of 2 by 2 and 3 by 3 matrices. Students are familiar with the geometric interpretations of matrices as area and volume of the parallelepipeds spanned by the images under the matrices of the standard basis vectors in 2-dimensional and 3-dimensional space.
- 11.0 Students know that a square matrix is invertible if, and only if, its determinant is non-zero and compute the inverse to 2 by 2 and 3 by 3 matrices using row reduction methods or Cramer's rule.
- 12.0 Students compute the scalar (dot) product of two vectors in n-dimensional space and know that perpendicular vectors have zero dot product.
- 13.0 Students know the Binomial Theorem and use it to expand binomial expressions that are raised to positive integer powers.

14.0 Students apply the method of mathematical induction to prove general statements about the positive integers.

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

PROBABILITY AND STATISTICS

This discipline is an introduction to the study of probability, interpretation of data, and fundamental statistical problem solving. Mastery of this academic content will provide students with a solid foundation in probability and facility with processing statistical information.

- 1.0 Students know the concept of independent events and use addition, multiplication, and complementation rules to solve for probabilities of particular events in finite sample spaces.
- 2.0 Students know the definition of conditional probability, and use it to solve for probabilities in finite sample spaces.
- 3.0 Students understand the concept of discrete random variables and use them to solve for the probabilities of outcomes.
- 4.0 Students are familiar with the standard distributions (normal, binomial, and exponential) and use them to solve for events in problems where the distribution belongs to these families.
- 5.0 Students determine the mean and standard deviation of a normally distributed random variable.
- 6.0 Students know the definitions of the mean, median, and mode of distribution of real valued data and compute them in particular situations.
- 7.0 Students compute the variance and standard deviation of a distribution of data.
- 8.0 Students organize and describe distributions of data using a number of different methods including frequency tables, histograms, standard line and bar graphs, stem and leaf displays, scatter plots, and box and whisker plots.
- 9.0 Students find the line of best fit to a given distribution of data using least squares regression.

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

STATISTICS Advanced Placement

AP Statistics is the secondary equivalent of an introductory, noncalculus-based college course in statistics. Mastery of advanced placement content prepares students for the Advanced Placement examination in Statistics.

- 1.0 Students solve probability problems with finite sample spaces using the addition, multiplication, and complementation rules for probability distributions, and understand the simplifications that arise with independent events.
- 2.0 Students know the definition of conditional probability and use it to solve for probabilities in finite sample spaces.
- 3.0 Students demonstrate understanding of the notion of discrete random variables by using them to solve for the probabilities of outcomes, such as the probability of the occurrence of five or fewer heads in fourteen coin tosses.
- 4.0 Students understand the notion of a continuous random variable, and can interpret the probability of an outcome as the area of a region under the graph of the probability density function associated with the random variable.
- 5.0 Students know the definition of the mean of a discrete random variable, and can determine it for a particular discrete random variable.
- 6.0 Students know the definition of the variance of a discrete random variable, and can determine it for a particular discrete random variable.
- 7.0 Students demonstrate understanding of the standard distributions (normal, binomial, and exponential), and can use them to solve for events in problems where the distribution belongs to these families.
- 8.0 Students determine the mean and standard deviation of a normally distributed random variable.
- 9.0 Students know the Central Limit Theorem, and can use it to obtain approximations for probabilities in finite sample spaces problems whose probabilities are distributed binomially.
- 10.0 Students know the definitions of the mean, median, and mode of distribution of real valued data, and can compute them in particular situations.
- 11.0 Students compute the variance and standard deviation of a distribution of data.
- 12.0 Students find the line of best fit to a given distribution of data using least squares regression.

- 13.0 Students know the definition of the correlation coefficient of two variables, and are familiar with its properties.
- 14.0 Students organize and describe distributions of data using a number of different methods, including frequency tables, histograms, standard line and bar graphs, stem and leaf displays, scatter plots, and box and whisker plots.
- 15.0 Students are familiar with the notions of a statistic of a distribution of values, of the sampling distribution of a statistic, and of the variability of a statistic.
- 16.0 Students know basic facts concerning the relation between the mean and standard deviation of a sampling distribution and the mean and standard deviation of the population distribution.
- 17.0 Students determine confidence intervals for a simple random sample from a normal distribution of data, and determine the sample size required for a desired margin of error.
- 18.0 Students conduct a test of significance, stating null and alternative hypotheses and correct conclusions.
- 19.0 Students justify the use of various tests, particularly the t-test, citing necessary conditions and addressing assumptions necessary for the test.
- 20.0 Students determine the P-value for a statistic for a simple random sample from a normal distribution, and are able to explain the significance of the P-value.
- 21.0 Students are familiar with the chi-square distribution and test, and understand its uses.

Tustin Unified School District

Mathematics Content Standards

Adopted by the Board of Education 6/22/98

CALCULUS

AP Calculus is a college level course in one variable calculus based on the advance placement curriculum set forth by the College Board. Two levels of calculus are offered, AP calculus AB and AP Calculus BC. Calculus is presented with the same depth and rigor as in an entry level college or university course in one variable calculus. Furthermore, all topics in AP Calculus AB are taught at the same level as in the AP Calculus BC course; the BC course contains additional topics not taught in AP Calculus AB. Each course will include extensive exposure to both the intrinsic theory and the applications of calculus.

Note: 1-23 applies to AP Calculus AB and 1-29 applies to AP Calculus BC

- 1.0 Students demonstrate knowledge of both the formal definition and the graphical interpretation of limit of values of functions. This includes one-sided limits, infinite limits, and limits at infinity. Students know the definition of convergence and divergence of a function as the domain variable either approaches a number or infinity.
 - 1.1 Students prove and use theorems evaluating the limits of sums, products, quotients, and composition of functions.
 - 1.2 Students verify and estimate limits using graphical calculators.
 - 1.3 Students prove and use special limits such as limits of $\frac{\sin(x)}{x}$ and $\frac{1 - \cos(x)}{x^2}$ as x tends to 0.
- 2.0 Students demonstrate knowledge of both the formal definition and graphical interpretation of continuity of a function.
- 3.0 Students demonstrate understanding and application of the Intermediate Value Theorem and the Extreme Value Theorem.
- 4.0 Students demonstrate understanding of the formal definition of the derivative of a function at a point, and the notion of differentiability.
 - 4.1 Students demonstrate understanding of the derivative of a function as the slope of the tangent line to the graph of the function.
 - 4.2 Students demonstrate understanding of the interpretation of the derivative as instantaneous rate of change. Students can use derivatives to solve a variety of problems coming from physics, chemistry, economics, etc, that involve the rate of change of a function.

- 4.3 Students understand the relation between differentiability and continuity.
- 4.4 Students derive derivative formulas and use them to find the derivatives of algebraic, trigonometric, inverse trigonometric, exponential, and logarithmic functions.
- 5.0 Students know the Chain Rule and its proof and applications to the calculation of the derivative of a variety of composite functions.
- 6.0 Students find the derivatives of parametrically defined functions and use implicit differentiation in a wide variety of problems coming from physics, chemistry, economics, etc.
- 7.0 Students compute derivatives of higher orders.
- 8.0 Students know and can apply Rolle's theorem, the Mean Value Theorem, and L'Hopital's rule.
- 9.0 Students use differentiation to sketch, by hand, graphs of functions. They can identify maxima, minima, inflection points, and intervals where the function is increasing and decreasing.
- 10.0 Students know Newton's method for approximating the zeros of a function.
- 11.0 Students use differentiation to solve optimization (maximum – minimum problems) in a variety of pure and applied contexts.
- 12.0 Students use differentiation to solve related rate problems in a variety of pure and applied contexts.
- 13.0 Students know the definition of the definite integral using Riemann sums. They use this definition to approximate integrals.
- 14.0 Students apply the definition of the integral to model problems in physics, economics, etc, obtaining results in terms of integrals.
- 15.0 Students demonstrate knowledge of and proof of the Fundamental Theorem of Calculus, and use it to interpret integrals as anti-derivatives.
- 16.0 Students use definite integrals in problems involving area, velocity, acceleration, volume of a solid, area of a surface of revolution, length of a curve, and work.
- 17.0 Students compute, by hand, the integrals of a wide variety of functions using techniques of integration such as: substitution, integration by parts, trigonometric substitution, and simple partial fractions. They can also combine these techniques when appropriate.
- 18.0 Students know the definitions and properties of inverse trigonometric functions and compute derivatives and integrals involving inverse trigonometric functions.
- 19.0 Students compute, by hand, the integrals of rational functions by combining the above techniques with the algebraic techniques of partial fractions and completing the square.
- 20.0 Students compute the integrals of trigonometric functions using the above techniques.

- 21.0 Students understand the algorithms involved in Simpson's rule. They use calculators and/or computers to approximate integrals numerically.
- 22.0 Students understand the algorithms involved in Newton's method. They use calculators and/or computers to approximate integrals numerically.
- 23.0 Students know the techniques of solution of selected elementary differential equations, and their applications to a wide variety of situations, including growth and decay problems.
- 24.0 Students understand improper integrals as limits of definite integrals.
- 25.0 Students demonstrate understanding of the definitions of convergence and divergence of sequences and series of real numbers. They can determine whether a series converges using such tests as the comparison test, ratio test, and alternate series test.
- 26.0 Students understand and can compute the radius (interval) of convergence of power series.
- 27.0 Students differentiate and integrate the terms of a power series in order to form new series from known ones.
- 28.0 Students calculate Taylor polynomials and Taylor series of basic functions, including the remainder term.
- 29.0 Students can solve logistic differential equations and use them in modeling. Students model solutions to differential equations using slope fields.