



Standards Overview

Shanghai American School

Mathematics



Grade 5

I. Number and Operations

Standard I Number and Operations - Understand numbers, ways of representing numbers, relationships among numbers and number systems - Understand meanings of operations and how they relate to one another - Compute fluently and make reasonable estimates

- 1. Read and represent whole numbers up to a billion [17]
- 2. Interpret and model tenths, hundredths, and thousandths [38]
- 3. Interpret, rename and model common fractions [10]
- 4. Recognize the relationship between fractions and division [7]
- 5. Read and represents decimals to thousandths [42]
- 6. Identify and generate equivalent fractions [14]
- 7. Compare and order large numbers to a billion [10]
- 8. Multiply decimal numbers by whole numbers [17]
- 9. Divide decimal numbers by whole numbers [10]
- 10. Solve and create addition and subtraction problems involving whole numbers

Grade 6

I. Number and Operations

Standard I Number and Operations - Understand numbers, ways of representing numbers, relationships among numbers and number systems - Understand meanings of operations and how they relate to one another - Compute fluently and make reasonable estimates

- 1. Find and use the prime factorization of composite numbers. For example: a) Use the prime factorization to recognize the greatest common factor (GCF) b) Use the prime factorization to recognize the least common multiple (LCM)
- 2. Decompose and recompose whole numbers using factors and exponents (e.g., $32 = 2 \times 2 \times 2 \times 2 \times 2 = 2$ to the 5th power), and explain why "squared" means "2nd power" and "cubed" means "3rd power" [7]
- 3. Apply computational procedures in a wide variety of problem solving situations involving fractions, decimals, ratios, percents, proportions, integers and positive exponents [24]
- 4. Explain and use the relationships among fractions, decimals and percents, and that numbers can be represented in more than one way [24]
- 5. Use and apply ratio, rate, unit rate, proportion and percent to represent quantitative relationships [11]
- 6. Model percents

Grade 7

I. Number and Operations

Standard I Number and Operations - Understand numbers, ways of representing numbers, relationships among numbers and number systems - Understand meanings of operations and how they relate to one another - Compute fluently and make reasonable estimates

- 1. Apply the prime factorization to solve problems and explain solutions [6]
- 2. Apply computational procedures in a wide variety of problem solving situations involving exponents and the laws of exponents [16]
- 3. Exhibit fluency of ratio, rate, unit rate, proportion and percent to solve application problems [5]
- 4. Explain why a number is "rational or irrational" [14]
- 5. Use scientific notation to express large numbers and small numbers between 0 and 1 [13]
- 6. Represent and solve problems using the concepts of absolute value, exponents and square roots (for perfect squares) [7]
- 7. Determine when an estimate is sufficient and when an exact

Grade 8

I. Number and Operations

Standard I Number and Operations - Understand numbers, ways of representing numbers, relationships among numbers and number systems - Understand meanings of operations and how they relate to one another - Compute fluently and make reasonable estimates

- 1. Compare, order, and determine equivalent forms for rational and irrational numbers [13]
- 2. Perform arithmetic operations on numbers written in scientific notation [3]
- 3. Perform operations on and simplify expressions involving radicals [5]

Grades 9-12

Pre Calculus Standard I Number and Operations -

Understand numbers, ways of representing numbers, relationships among numbers and number systems - Understand meanings of operations and how they relate to one another - Compute fluently and make reasonable estimates

- 1. Illustrate which properties hold for vector addition and scalar multiplication [3]
- 2. Model using the coordinate plane, vector addition, and scalar multiplication [3]
- 3. Convert between Cartesian and polar representations of complex numbers
- 4. Illustrate which properties hold for addition and multiplication of complex numbers
- 5. Illustrate which properties hold for addition and multiplication of matrices [4]
- 6. Perform basic operations (sums, products, and row reductions) on matrices using paper and pencil calculations for simple cases and technology for more complicated cases [4]
- 7. Identify arithmetic, geometric, and other sequences, and compute finite and infinite sums (where possible) of such sequences [4]
- 8. Expand powers of binomials using the Binomial Theorem

All Grades

Process Standards Problem Solving

- Build new mathematical knowledge through problem solving
- Solve problems that arise in mathematics and in other contexts
- Apply and adapt a variety of appropriate strategies to solve problems
- Monitor and reflect on the process of mathematical problem solving

Reasoning and Proof

- Recognize reasoning and proof as fundamental aspects of mathematics
- Make and investigate mathematical conjectures
- Develop and evaluate mathematical arguments and proofs
- Select and use various types of reasoning and methods of proof

Communication

- Organize and consolidate their mathematical thinking through communication
- Communicate their mathematical thinking coherently and clearly to peers, teachers
- Analyze and evaluate the mathematical thinking and strategies of others

<p>and/or decimals [10]</p> <ul style="list-style-type: none"> 11. Solve and create multiplication and division problems involving whole numbers and/or decimals [10] 12. Estimate sums and differences involving decimals to the thousandths [10] 13. Compare and order decimals numbers [38] 14. Compare and order fractions using informal and formal methods [27] 15. Separate composite numbers into their factors [10] 16. Find sums of differences involving decimals to thousandths [10] 17. Multiply 2, 3, and 4 digit numbers by 2 digit whole numbers [30] 18. Calculate the product of 3 digit numbers [10] 19. Divide by single digit numbers [23] 20. Analyze and solve multi-step problems involving addition, subtraction, multiplication and division using an organized approach, and verify and interpret results with respect to the original problem [10] 	<p>less than 1 and greater than 100 [10]</p> <ul style="list-style-type: none"> 7. Use the order of operations to simplify numerical expressions [11] 8. Simplify expressions involving integers to represent and solve problems [3] 9. Apply multiplication and division to problems involving fractions and decimals [11] 	<p>answer is needed in problem situations, and evaluate estimates in relation to actual answers (e.g., very close, less than, greater than) [27]</p> <ul style="list-style-type: none"> 8. Estimate, compute and solve problems involving rational numbers, including ratio, proportion and percent [2] 	<p>binomial theorem and apply the resulting binomial coefficients to general combinatorial problems [7]</p>	<p>Use the language of mathematics to express mathematical ideas precisely</p>
<p>Connections</p> <ul style="list-style-type: none"> Recognize and use connections among mathematical ideas Understand how mathematical ideas interconnect and build on one another Recognize and apply mathematics in contexts outside of mathematics 				
<p>Representation</p> <ul style="list-style-type: none"> Create and use representations to organize, record, and communicate mathematical ideas Select, apply, and translate among mathematical representations to solve problems Use representations to model and interpret physical, social, and mathematical phenomena 				
<p>Standard II Algebra - Understand patterns, relations, and functions - Represent and analyze mathematical situations and structures using algebraic symbols - Use mathematical models to represent and understand quantitative relationships - Analyze change in various contexts</p> <ul style="list-style-type: none"> 1. Describe and compare the characteristics of algebraic and transcendental functions (e.g., general shape of the graphs, nature of zeros, domain and range, asymptotic behavior, continuity, extrema, local and global behavior) [9] 2. Use vector addition, scalar multiplication, and dot product of vectors to solve problems [3] 3. Decompose rational functions into partial fractions (involving linear, repeated, and irreducible quadratic factors) [1] 4. Solve systems of linear equations with a variety of matrix techniques (Cramer's Rule, matrix inverse, and row reduction), using technology for more complex systems [3] 5. Analyze transformations of functions (polynomial, rational, radical, exponential, logarithmic, and trigonometric) and the impact of these transformations on their graphs 				

- [23]
- 6. Identify amplitude, period, and phase shifts in trigonometric functions and the impact on their graphs [9]
- 7. Analyze functions given either in parametric or polar form [3]
- 8. Solve rational and radical inequalities [7]
- 9. Derive and apply the basic trigonometric identities, the Pythagorean, sum and difference, double and half-angle identities [13]
- 10. Solve trigonometric equations [2]
- 11. Describe and compare the characteristics of the graphs of conic sections [1]

Standard III Geometry
- Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems
- Apply transformations and use symmetry to analyze mathematical situations
- Use visualization, spatial reasoning, and geometric modeling to solve problems

- 1. Use polar coordinates to specify geometrical objects
- 2. Use trigonometric methods to solve problems of geometry [6]
- 3. Interpret geometrically the operations of vector addition, scalar

multiplication,
and the dot
product of vectors
[3]

- 4. Use vector models to solve and interpret problems of geometrical and practical interest (e.g., homogeneous and inhomogeneous systems of linear equations, parametric equations, or problems involving lines and planes in 3-space)
[3]
- 5. Represent the solution of a system of linear equations as the intersection of lines (in 2-space) and planes (in 3-space)
[5]
- 6. Translate freely between algebraic and geometric representations of conic sections
[1]

**Standard IV
Measurement -
Understand measurable
attributes of objects
and the units, systems,
and processes of
measurement - Apply
appropriate techniques,
tools, and formulas to
determine
measurements**

- 1. Apply radian measure to solve problems involving linear and angular velocity
[5]
- 2. Calculate the length of an arc or the area of a sector or segment
[5]
- 3. Calculate and interpret the magnitude of a vector in two- and threedimensional space
[3]

**Standard V Data
Analysis and
Probability - Formulate
questions that can be
addressed with data
and collect, organize,
and display relevant
data to answer them -
Select and use**

appropriate statistical methods to analyze data - Develop and evaluate inferences and predictions that are based on data - Understand and apply basic concepts of probability

- 1. Create a scatter plot of bivariate data, identify trends, and use technology to find a function to model the data
- 2. Use technology to find the least-squares regression line and the correlation coefficient for bivariate data with a linear trend and interpret each of these statistics in the context of the given problem
- 3. Transform bivariate data so that it can be modeled by a function of a given type (e.g., use logarithms to transform nonlinear data into data more closely approximated by linear regression)
- 4. Use technology to compute measures of central tendency (mean, median, and mode) and measures of spread (range, quartiles, and standard deviation) and interpret in the context of the problem
- 5. Describe the standard normal curve and its general properties, and answer questions about with data assumed to be sampled from a normal distribution
- 6. Analyze and interpret univariate and bivariate data to identify patterns, note trends, draw conclusions, and make predictions
- 7. Use theoretical or experimental probability, including

simulations, to determine probabilities in real-world problem situations
[3]

- 8. Understand and be able to apply the concepts of mutually exclusive, complementary, and independent events to probabilistic or statistical problems
[3]
- 9. Understand and be able to apply the concept of conditional probability
[3]
- 10. Construct and interpret confidence intervals computed from random samples

Standard VI Problem Solving - Build new mathematical knowledge through problem solving - Solve problems that arise in mathematics and in other contexts - Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving

- 1. Use a variety of problem-solving strategies relevant to the level of mathematics of the course and reflect on this process
[43]

Standard VII Reasoning and Proof - Recognize reasoning and proof as fundamental aspects of mathematics - Make and investigate mathematical conjectures - Develop and evaluate mathematical arguments and proofs - Select and use various types of reasoning and methods of proof

- 1. Recognize, understand, and develop the concept of mathematical proof as a fundamental

aspect of mathematics at a level appropriate to the course
[35]

- 2. Construct arguments based on the principle of mathematical induction
[7]

**Standard VIII
Communication -
Organize and consolidate their mathematical thinking through communication
- Communicate their mathematical thinking coherently and clearly to peers, teachers and others - Analyze and evaluate the mathematical thinking and strategies of others
- Use the language of mathematics to express mathematical ideas precisely**

- 1. Organize, consolidate, analyze, and evaluate their mathematical thinking at a level appropriate to the level of the course
[50]
- 2. Translate mathematical expressions into precise language for technology relevant to the level of the course
[51]
- 3. Translate verbal expressions into precise mathematical language to the level of the course
[48]

**Standard IX
Connections -
Recognize and use connections among mathematical ideas -
Understand how mathematical ideas interconnect and build on one another to produce a coherent whole - Recognize and apply mathematics in contexts outside of mathematics**

- 1. Recognize and use connections among mathematical ideas appropriate to the mathematical

level of the
course
[52]

Standard X
Representation - Create and use representations to organize, record, and communicate mathematical ideas - Select, apply, and translate among mathematical representations to solve problems - Use representations to model and interpret physical, social, and mathematical phenomena

- 1. Create, use, select, apply, and translate mathematical representations appropriate to the level of the course [49]
- 2. Translate freely between such alternative representations as Cartesian versus polar coordinates

II. Algebra

Standard II Algebra - Understand patterns, relations, and functions - Represent and analyze mathematical situations and structures using algebraic symbols - Use mathematical models to represent and understand quantitative relationships - Analyze change in various contexts

- 1. Solve problems by using patterns [4]
- 2. Use variables as unknown quantities (e.g., $a + 7 = 10$) [20]
- 3. Continue a pattern from a given rule and extend it
- 4. Model patterns with physical materials and represent these patterns in charts [7]
- 5. Create a

II. Algebra

Standard II Algebra - Understand patterns, relations, and functions - Represent and analyze mathematical situations and structures using algebraic symbols - Use mathematical models to represent and understand quantitative relationships - Analyze change in various contexts

- 1. Use words and symbols to predict and describe numerical and geometric patterns and rules [6]
- 2. Evaluate simple expressions through substitution of variables [6]
- 3. Model real-life situations using algebraic expressions and equations [6]
- 4. Solve one and two-step single variable equations with integers, fractions and decimals using inverse operations [6]
- 5. Graph ordered pairs on a coordinate plane and identify

II. Algebra

Standard II Algebra - Understand patterns, relations, and functions - Represent and analyze mathematical situations and structures using algebraic symbols - Use mathematical models to represent and understand quantitative relationships - Analyze change in various contexts

- 1. Represent and analyze patterns, rules and functions, with words and simple variable expressions [11]
- 2. Solve multiple-step equations with and without variables on both sides using inverse operations [9]
- 3. Solve simple linear equations and inequalities using physical models, paper and pencil, tables and

II. Algebra

Standard II Algebra - Understand patterns, relations, and functions - Represent and analyze mathematical situations and structures using algebraic symbols - Use mathematical models to represent and understand quantitative relationships - Analyze change in various contexts

- 1. Show the domain and range of relations and functions [5]
- 2. Recognize, represent and analyze patterns of linear, quadratic, absolute value, radical and exponential functions through tables, graphs and algebraic representations [33]
- 3. Model and solve real-life situations using linear (equations

Contemporary Mathematics

Standard I Number and Operations - Understand numbers, ways of representing numbers, relationships among numbers and number systems - Understand meanings of operations and how they relate to one another - Compute fluently and make reasonable estimates

- 1. Use both the Banzhaf and the Shapley-Shubik Power Indexes to determine the effect each member of a board has on voting outcomes. [5]

Standard III Geometry - Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships - Specify locations and describe spatial relationships using coordinate geometry and other representational

<p>general rule from a pattern using words, graphs and physical materials [7]</p> <ul style="list-style-type: none"> 6. Determine whether an open sentence is always, sometimes or never true [14] 	<p>quadrants [6]</p>	<p>graphs [8]</p> <ul style="list-style-type: none"> 4. Produce and interpret graphs that represent the relationship between two variables [10] 5. Represent linear equations by plotting points in a coordinate plane [5] 6. Represent inequalities on a number line or a coordinate plane [5] 7. Justify that two forms of an algebraic expression are equivalent, and recognize when an expression is simplified (e.g., $4m = m+m+m+m$ or $5a + 4a = 9a$) [13] 8. Use formulas in problem-solving situations [16] 9. Recognize a variety of uses for variables (e.g., place holder for an unknown quantity in an equation, generalization for a pattern, formula) [17] 10. Analyze linear and simple nonlinear relationships to explain how a change in one variable results in the change in another [5] 11. Use graphing calculators or computers to analyze change (e.g., distance-time relationships) 	<p>and inequalities), quadratic and exponential models through tables, graphs and algebraic representations [44]</p> <ul style="list-style-type: none"> 4. Identify the relationship between zeros of a function and roots of equations [5] 5. Write and use equivalent forms of equations (such as writing linear equations in slope-intercept form), and inequalities [23] 6. Recognize and explain that the slopes of parallel lines are equal and the slopes of perpendicular lines are negative reciprocals [10] 7. Solve systems of linear equations and inequalities using graphs, substitution, and elimination [8] 8. Solve quadratic equations with real roots by factoring, graphing, and using the quadratic formula [10] 9. Perform operations on algebraic expressions involving monomials and polynomials [18] 10. Transpose equations for a specified variable given more than one variable [10] 11. Solve and simplify radical equations [5] 12. Calculate exponential growth and decay (e.g., compound interest) [5] 13. Evaluate functions graphically, numerically and algebraically 	<p>systems - Apply transformations and use symmetry to analyze mathematical situations - Use visualization, spatial reasoning, and geometric modeling to solve problems</p> <ul style="list-style-type: none"> 1. Determine the fair division of a divisible object (i.e., cake) by assigning preferences and calculating angle measurements [5] 2. Apply the Brute-Force, Nearest-Neighbor, Repetitive Nearest-Neighbor, and Cheapest-Link Algorithms to solve the Traveling Salesman Problem [6] 3. Use Torricelli's construction Method to locate the Steiner Point in a triangle (networks) [7] 4. Determine the shortest network connecting 3 or more points using Kruscal's Algorithm [7] <p>Standard IV Measurement - Understand measurable attributes of objects and the units, systems, and processes of measurement - Apply appropriate techniques, tools, and formulas to determine measurements</p> <ul style="list-style-type: none"> 1. Use compass to locate the Steiner point in a triangle [7] <p>Standard V Data Analysis and Probability - Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them - Select and use appropriate statistical methods to analyze data - Develop and evaluate inferences and predictions that are based on data - Understand and apply</p>
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- algebraically
[29]
- basic concepts of probability
- 14. Describe how a change in the value of a constant in linear and quadratic equations affects the related graphs [15]
 - 15. Solve multi-step linear equations and inequalities (including compound) using a variety of methods [21]
- 1. Summarize data using mean, mode, the 5-number summary (min, Q1, median, Q3, max) and measures of spread (Chapter 14) [7]
 - 2. Describe populations and how surveys and random sampling can be used to collect data [7]
 - 3. Use technology to compute measures of central tendency (mean, median, and mode) and measures of spread (range, quartiles, and standard deviation) and interpret in the context of the problem [7]
 - 4. Use theoretical or experimental probability, including simulations, to determine probabilities in real-world problem situations [8]
 - 5. Understand and be able to apply the concepts of mutually exclusive, complementary, and independent events to probabilistic or statistical problems [6]
 - 6. Understand and be able to apply the concept of conditional probability [6]
 - 7. Fit data to and solve problems involving normal distribution curves [2]

Standard VI Problem Solving - Build new mathematical knowledge through problem solving - Solve problems that arise in mathematics and in other contexts - Apply and adapt a variety of

appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving

- 1. Use a variety of problem-solving strategies relevant to the level of mathematics of the course and reflect on this process [50]
- 2. Determine the outcome of an election (winner, as well as ranking) using various methods (plurality, plurality-with-elimination, Borda Count, and Pairwise Comparisons) [5]
- 3. Use both the Banzhaf and the Shapley-Shubik Power Indexes to determine the effect each member of a board has on voting outcomes [5]
- 4. Solve problems of fair division involving divisible objects using various methods (divider-chooser, lone-divider, lone-chooser, and lastdiminisher methods) [5]
- 5. Solve problems of fair division involving indivisible, discrete objects using various methods (sealed-bids and the method of markers) [5]
- 6. Solve problems such as the Street-sweeping problem using Fluery's Algorithm or the Eulerization of graphs [5]
- 7. Apply the Brute-Force, Nearest-Neighbor, Repetitive Nearest-Neighbor, and Cheapest-Link Algorithms to solve the Traveling

Salesman
Problem

[5]

- 8. Schedule tasks in an efficient way using a priority list (alphabetical, decreasing-time, and critical path)
[6]

Standard VII Reasoning and Proof - Recognize reasoning and proof as fundamental aspects of mathematics - Make and investigate mathematical conjectures - Develop and evaluate mathematical arguments and proofs - Select and use various types of reasoning and methods of proof

- 1. Determine the role each player makes in a weighted voting system (dictator, dummy or has veto power)
[5]
- 2. Recognize and understand instances of the Quota Rule violation and the Alabama, New-States, and Population Paradoxes
[6]
- 3. Understand Arrow's Impossibility Theorem and its ramifications
[5]

Standard VIII Communication - Organize and consolidate their mathematical thinking through communication - Communicate their mathematical thinking coherently and clearly to peers, teachers and others - Analyze and evaluate the mathematical thinking and strategies of others - Use the language of mathematics to express mathematical ideas precisely

- 1. Organize, consolidate, analyze, and evaluate their mathematical thinking at a level appropriate to the level of the course
[48]
- 2. Translate

mathematical
expressions into
precise language
for technology
relevant to the
level of the
course
[42]

- 3. Translate verbal expressions into precise mathematical language to the level of the course
[48]
- 4. Apply the language of mathematics to formulate problems from social science and politics (voting, division, apportionment, and measurements of power)
[17]
- 5. Apply the language of probability and statistics to formulate and solve problems involving random behavior
[9]

Standard IX
Connections -
Recognize and use
connections among
mathematical ideas -
Understand how
mathematical ideas
interconnect and build
on one another to
produce a coherent
whole - Recognize and
apply mathematics in
contexts outside of
mathematics

- 1. Recognize and use connections among mathematical ideas appropriate to the mathematical level of the course
[51]

Standard X
Representation - Create
and use
representations to
organize, record, and
communicate
mathematical ideas -
Select, apply, and
translate among
mathematical
representations to
solve problems - Use
representations to
model and interpret
physical, social, and
mathematical

phenomena

- 1. Create, use, select, apply, and translate mathematical representations appropriate to the level of the course [45]
- 2. Create and use Preference Ballots/Schedules to organize voting data [5]
- 3. Use spreadsheets to apportion seats by means of Hamilton's, Jefferson's, Adams', and Webster's Methods [6]
- 4. Use graphs (vertices and edges) to represent real-life situations and to show connections [12]
- 5. Display efficient scheduling in a horizontal bar graph [6]
- 6. Use graphs (pie-chart, bar graphs, and histograms) to represent real-life situations and to show connections [7]
- 7. Apply box-and-whisker plots to display central tendency and range of data [7]

III: Geometry Standard III Geometry - Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships - Specify locations and describe spatial relationships using coordinate geometry and other representational systems - Apply transformations and use symmetry to analyze mathematical situations - Use visualization, spatial	III: Geometry Standard III Geometry - Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships - Specify locations and describe spatial relationships using coordinate geometry and other representational systems - Apply transformations and use symmetry to analyze mathematical situations - Use visualization, spatial reasoning, and geometric modeling to solve problems <ul style="list-style-type: none">• 1. Classify and	III: Geometry Standard III Geometry - Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships - Specify locations and describe spatial relationships using coordinate geometry and other representational systems - Apply transformations and use symmetry to analyze mathematical situations - Use visualization, spatial reasoning, and geometric modeling to	III: Geometry Standard III Geometry - Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships - Specify locations and describe spatial relationships using coordinate geometry and other representational systems - Apply transformations and use symmetry to analyze mathematical situations - Use visualization, spatial reasoning, and geometric modeling to	Algebra 1 Standard I Number and Operations -Understand numbers, ways of representing numbers, relationships among numbers and number systems - Understand meanings of operations and how they relate to one another -Compute fluently and make reasonable estimates <ul style="list-style-type: none">• 1. Compare, order, and determine equivalent forms for rational and irrational numbers [2]
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reasoning, and geometric modeling to solve problems

- 1. Recognize, name, describe and represent perpendicular lines/segments, bisectors of angles and segments, and perpendicular-bisectors of segments [7]
- 2. Construct and describe right, obtuse, acute and scalene triangles [14]
- 3. Generalize about the diagonal properties of squares and rectangles and apply these properties (e.g., diagonals of squares and rectangles both bisect each other and diagonals of squares and rectangles both form 45 degree angles) [14]
- 4. Generalize about the properties of translations and reflections and apply these properties (e.g.; changing a triangle to a parallelogram by cutting off the triangle formed by joining the midpoints of two sides and rotating it about either of those midpoints) [7]
- 5. Explore quarter, half and three quarter-turn rotations with different centers [25]
- 6. Make generalizations about the rotation symmetry property of squares and rectangles, [25]
- 7 Draw circles

describe two-dimensional and three-dimensional geometric figures and objects by using their properties (e.g., interior angle measures, perpendicular/parallel sides, congruent angles/sides) [7]

- 2. Classify and measure angles e.g., supplementary, complementary, acute, obtuse, straight, right, reflex [7]
- 3. Identify and define relationships between lines; i.e., parallel, perpendicular and intersecting [7]
- 4. Define and classify properties of quadrilaterals and define the relationship between them [7]
- 5. Define and classify properties of triangles (e.g., the sum of the measures of the angles of a triangle is 180 degrees) [7]
- 6. Draw similar figures using scale factors [10]
- 7. Use geometric software or tools to complete basic geometric constructions (angles, bisectors, shapes, etc.) [7]

solve problems

- 1. Use the Pythagorean theorem to solve problems involving right triangles [5]
- 2. Use and apply proportional reasoning to describe and express relationships between parts and attributes of similar and congruent figures [11]
- 3. Determine necessary conditions for congruence of triangles [9]
- 4. Apply properties of congruent or similar triangles to solve problems involving missing lengths and angle measures [10]
- 5. Recognize the angles formed and the relationship between the angles when two lines intersect and when parallel lines are cut by a transversal [6]
- 6. Identify the line of symmetry and point of rotation of two-dimensional figures to solve problems [2]
- 7. Predict, describe and perform translations, reflections, rotations and dilations of two-dimensional figures using a variety of methods

solve problems

- 1. Evaluate real-world problems using the Pythagorean theorem [6]
- 2. Demonstrate and apply the relationship between the Pythagorean theorem and the distance formula [3]
- 3. Use graphical and algebraic methods to solve problems involving distance, midpoint, and slope [8]
- 4. Transform basic functions (e.g., parabolas, absolute value) on a coordinate plane [13]

- 2. Perform arithmetic operations on numbers written in scientific notation [2]
- 3. Explain the meaning of square root, and estimate the square root of a given positive integer by locating it between consecutive integers (e.g., the square root of 70 is between 8 and 9) [2]
- 3. Perform operations on and simplify expressions involving radicals (including estimating square roots and simplifying $3/\sqrt{2}$)

Standard II Algebra - Understand patterns, relations, and functions - Represent and analyze mathematical situations and structures using algebraic symbols - Use mathematical models to represent and understand quantitative relationships - Analyze change in various contexts

- 1. Find the domain and range of relations and functions [4]
- 2. Recognize, represent and analyze patterns of linear, quadratic, absolute value, radical and exponential functions through tables, graphs and algebraic representations [13]
- 3. Model and solve real-life situations using linear (equations and inequalities), quadratic and exponential models through tables, graphs and algebraic representations [10]
- 4. Identify the relationship between zeros of a function and

- 7. Draw circles and determine relationships between the radius, diameter, center and circumference [12]
 - 8. Recognize and represent figures and transformed to other figures
 - 9. Explore how figures can be dissected and transformed to other figures (i.e., rectangle into a parallelogram) [14]
 - 10. Identify and define triangles based on side lengths (isosceles, equilateral, and scalene triangles) [14]
 - 11. Specify locations and plot ordered pairs on a coordinate plane (i.e., able to plot -1, -1) [21]
- roots of equations, both graphically and in words [6]
 - 5. Write and use equivalent forms of equations (such as writing linear equations in slope-intercept form), and inequalities [3]
 - 6. Recognize and explain that the slopes of parallel lines are equal and the slopes of perpendicular lines are negative reciprocals [3]
 - 7. Solve systems of linear equations and inequalities using graphs, substitution, and elimination [2]
 - 8. Solve quadratic equations with real roots by factoring, graphing, and using the quadratic formula [5]
 - 9. Perform operations on algebraic expressions involving monomials and polynomials [5]
 - 10. Transpose equations for a specified variable given more than one variable [6]
 - 11. Simplify and perform operations on rational expressions, and solve rational equations [2]
 - 12. Simplify expressions and solve equations involving square roots [4]
 - 13. Calculate exponential growth and decay (e.g., compound interest) [2]
 - 14. Evaluate functions graphically, numerically and algebraically [6]
 - 15. Describe how a change in the

value of a constant in linear and quadratic equations affects the related graphs
[7]

- 16. Solve multi-step linear equations and inequalities (including compound) using a variety of methods
[3]
- 17. Differentiate between and explain types of changes in mathematical relationships in tabular, graphic and symbolic form (linear vs. nonlinear, continuous vs. noncontinuous, direct vs. indirect variation)
[7]

Standard III Geometry
- Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems
- Apply transformations and use symmetry to analyze mathematical situations
- Use visualization, spatial reasoning, and geometric modeling to solve problems

- 1. Model and solve real-world problems using the Pythagorean Theorem
[1]
- 2. Demonstrate and apply the relationship between the Pythagorean Theorem and the distance formula
[1]
- 3. Use graphical and algebraic methods to solve problems involving distance and slope
[3]
- 4. Transform basic functions (e.g., parabolas, absolute value)

on a coordinate
plane
[4]

**Standard IV
Measurement -
Understand measurable
attributes of objects
and the units, systems,
and processes of
measurement - Apply
appropriate techniques,
tools, and formulas to
determine
measurements**

- 1. Convert from one unit to another both between and within systems [2]
- 2. Solve simple problems involving rates and derived measurements for such attributes as velocity and density [7]
- 3. Check solutions to problems for reasonable results in context [2]

**Standard V Data
Analysis and
Probability - Formulate
questions that can be
addressed with data
and collect, organize,
and display relevant
data to answer them -
Select and use
appropriate statistical
methods to analyze
data - Develop and
evaluate inferences and
predictions that are
based on data -
Understand and apply
basic concepts of
probability**

- 1. Select, create, and use appropriate graphical representations of data using scatter plots
- 2. Analyze relationships between two characteristics of a sample on the basis of scatter plots of the data and approximate lines of fit
- 3. Judge whether a sample is representative, depending on a number of factors (e.g., amount of data collected, what is known

- about the situation, how current data are)
- 4. Understand the significance of such measures of central tendency as mean, median, and mode
- 5. Understand the significance of such measures of dispersion as range, quartiles, and outliers, and to represent them graphically (e.g., by using a box-and-whisker plot)

Standard VI Problem Solving - Build new mathematical knowledge through problem solving - Solve problems that arise in mathematics and in other contexts - Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving

- 1. Use a variety of problem-solving strategies relevant to the level of mathematics of the course and reflect on this process
[30]

Standard VII Reasoning and Proof - Recognize reasoning and proof as fundamental aspects of mathematics - Make and investigate mathematical conjectures - Develop and evaluate mathematical arguments and proofs - Select and use various types of reasoning and methods of proof

- 1. Recognize, understand, and develop the concept of mathematical proof as a fundamental aspect of mathematics at a level appropriate to the course
[15]

Standard VIII Communication - Organize and consolidate their mathematical thinking through communication

- Communicate their mathematical thinking coherently and clearly to peers, teachers and others - Analyze and evaluate the mathematical thinking and strategies of others - Use the language of mathematics to express mathematical ideas precisely

- 1. Organize, consolidate, analyze, and evaluate their mathematical thinking at a level appropriate to the level of the course
[26]
- 2. Translate mathematical expressions into precise language for technology relevant to the level of the course
[20]
- 3. Translate verbal expressions into precise mathematical language to the level of the course
[22]

**Standard IX
Connections -
Recognize and use connections among mathematical ideas -
Understand how mathematical ideas interconnect and build on one another to produce a coherent whole - Recognize and apply mathematics in contexts outside of mathematics**

- 1. Recognize and use connections among mathematical ideas appropriate to the mathematical level of the course
[24]

**Standard X
Representation - Create and use representations to organize, record, and communicate mathematical ideas -
Select, apply, and translate among mathematical representations to solve problems - Use representations to model and interpret**

physical, social, and mathematical phenomena

- 1. Create, use, select, apply, and translate mathematical representations appropriate to the level of the course [20]

IV: Measurement

Standard IV Measurement - Understand measurable attributes of objects and the units, systems, and processes of measurement - Apply appropriate techniques, tools, and formulas to determine measurements

- 1. Solve simple problems involving the perimeters areas of regular polygons
- 2. Calculate areas of triangles, rectangles, parallelograms and irregular quadrangles
- 3. Measure right angles, acute angles, obtuse angles and reflex angles [18]
- 4. Identify the relationship among the various metric units and the various U.S. customary systems and demonstrate the ability to convert between units
- 5. Develop a formula and calculate the area and perimeters of squares and rectangles [12]
- 6. Solve simple problems involving volumes and capacity [12]
- 7. Estimate angle size in degrees

IV: Measurement

Standard IV Measurement - Understand measurable attributes of objects and the units, systems, and processes of measurement - Apply appropriate techniques, tools, and formulas to determine measurements

- 1. Compare the relationship among commonly used units (customary and metric) and select appropriate units in given situations [8]
- 2. Investigate the relationships among geometric formulas to determine the circumference of circles and the area of triangles, parallelograms, and circles (e.g., area of the square to triangle) [7]
- 3. Select the appropriate measure (perimeter, area, surface area, volume) for real-world situations (e.g., perimeter is the context for fencing a garden, surface area is the context for painting a room) [8]
- 4. Solve problems involving perimeter (circumference) and area of various shapes (e.g., parallelograms, triangles, circles) [7]
- 5. Describe what happens to the perimeter and area of a two-dimensional shape when the measurements of the shape are changed (e.g., length of sides are doubled) [7]
- 6. Select and use appropriate estimation techniques to solve real-world problems

IV: Measurement

Standard IV Measurement - Understand measurable attributes of objects and the units, systems, and processes of measurement - Apply appropriate techniques, tools, and formulas to determine measurements

- 1. Convert units of area and volume within the same measurement system using proportional reasoning and a reference table when appropriate (e.g., square feet to square yards, cubic meters to cubic centimeters) [4]
- 2. Convert units between different measuring systems
- 3. Solve problems involving proportional relationships and scale factors (e.g., scale models that require unit conversions within the same measurement system; indirect measurement problems; trapezoids and surface area and volume of cylinders and prisms) [8]
- 4. Calculate the area of trapezoids, the volume of cones, and the and surface area and volume of cylinders

IV: Measurement

Standard IV Measurement - Understand measurable attributes of objects and the units, systems, and processes of measurement - Apply appropriate techniques, tools, and formulas to determine measurements

- 1. Describe relationships among units (metric and customary) and convert from one unit to another within the same system [5]
- 2. Solve simple problems involving rates and derived measurements for such attributes as velocity and density [5]

Algebra Part 2

Standard I Number and Operations
-Understand numbers, ways of representing numbers, relationships among numbers and number systems
-Understand meanings of operations and how they relate to one another
-Compute fluently and make reasonable estimates

- 1. Compare, order, and determine equivalent forms for irrational numbers
- 2. Perform arithmetic operations on numbers written in scientific notation
- 3. Perform operations on and simplify expressions involving radicals (including estimating square roots and simplifying 3/sq root of 2)

Standard II Algebra
-Understand patterns, relations, and functions
-Represent and analyze mathematical situations and structures using algebraic symbols
-Use mathematical models to represent and understand quantitative relationships
-Analyze change in various contexts

- 1. Find the domain and range of relations and functions
- 2. Recognize, represent and analyze patterns of radical and exponential functions through tables, graphs and algebraic

- degrees
[11]
- 8. Determine which unit is appropriate in a given situations and solve problems involving lengths and areas
[13]
 - 9. Use tools to draw angles and triangles
[14]
 - 10. Identify paths between points on a grid or coordinate plane and compare the lengths of the paths
[7]
 - 11. Write, solve and verify solutions to multi-step problems involving measurements
[7]
- [8]
- cylinders, pyramids and prisms
[4]
- 5. Find the area of composite two-dimensional shapes
[5]
- representations
- 3. Model and solve real-life situations using quadratic and exponential models through tables, graphs and algebraic representations
 - 4. Identify the relationship between zeros of a function and roots of equations, both graphically and in words
 - 5. Solve systems of linear equations and inequalities using graphs, substitution, and elimination
 - 6. Solve quadratic equations with real roots by factoring, graphing, and using the quadratic formula
 - 7. Perform operations on algebraic expressions involving monomials and polynomials
 - 8. Simplify and perform operations on rational expressions, and solve rational equations
 - 9. Simplify expressions and solve equations involving square roots
 - 10. Calculate exponential growth and decay (e.g., compound interest)

Standard III Geometry
-Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships
-Specify locations and describe spatial relationships using coordinate geometry and other representational systems
-Apply transformations and use symmetry to analyze mathematical situations
-Use visualization, spatial reasoning, and geometric modeling to solve problems

- 1. Model and

- solve real-world problems using the Pythagorean theorem
- 2. Demonstrate and apply the relationship between the Pythagorean theorem and the distance formula
- 3. Use graphical and algebraic methods to solve problems involving distance, midpoint, and slope

Standard IV Measurement

-Understand measurable attributes of objects and the units, systems, and processes of measurement

-Apply appropriate techniques, tools, and formulas to determine measurements

- 1. Describe relationships among units (metric and customary) and convert from one unit to another within the same system
- 2. Solve problems involving rates and derived measurements for such attributes as velocity and density
- 3. Check solutions to problems for reasonable results in context

Standard V Data Analysis

-Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them

-Select and use appropriate statistical methods to analyze data

-Develop and evaluate inferences and predictions that are based on data

-Understand and apply basic concepts of probability

- 1. Select, create, and use appropriate graphical representations of data

- 2. Discuss and understand the correspondence between data sets and their graphical representations

Standard VI Problem Solving

-Build new mathematical knowledge through problem solving
-Solve problems that arise in mathematics and in other contexts
-Apply and adapt a variety of appropriate strategies to solve problems
-Monitor and reflect on the process of mathematical problem solving

- 1. Build new mathematical knowledge through regular problem solving, including content and supplementary activities
- 2. Solve problems that arise in mathematics and in other contexts
- 3. Develop and apply strategies to a wide variety of problems, i.e. applying logical reasoning, use of manipulatives, identifying patterns, guess, check, and revise, work backwards, draw picture, table, diagram
- 4. Monitor and reflect on the process of problem solving (i.e., identifying extraneous information, estimating solutions for problems, determining the reasonableness of a solution by comparing it to an estimate, choosing an appropriate calculation method)
- 5. Formulate problems from everyday and mathematical situations

Standard VII Reasoning and Proof

-Recognize reasoning and proof as

fundamental aspects of mathematics**-Make and investigate mathematical conjectures****-Develop and evaluate mathematical arguments and proofs****-Select and use various types of reasoning and methods of proof**

- 1. Make and investigate mathematical conjectures of explore these conjectures
- 2. Recognize, understand and develop the concept of a mathematical proof as fundamental aspects of mathematics
- 3. Select and use various types of reasoning and methods of proof

Standard VIII**Communication****-Organize and consolidate their mathematical thinking through communication****-Communicate their mathematical thinking coherently and clearly to peers, teachers and others****-Analyze and evaluate the mathematical thinking and strategies of others****-Use the language of mathematics to express mathematical ideas precisely**

- 1. Organize and consolidate their mathematical thinking through communication
- 2. Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
- 3. Analyze and evaluate the mathematical thinking and strategies of others
- 4. Use the language of mathematics to express the mathematical ideas precisely
- 5. Translate mathematical expressions into precise language for technology

**Standard IX
Connections**

-Recognize and use connections among mathematical ideas
-Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
-Recognize and apply mathematics in contexts outside of mathematics

- 1. Recognize and use connections among mathematical ideas
- 2. Understand connections between equivalent representations and corresponding procedures of the same problem situation or mathematical concept
- 3. Recognize and apply mathematics in contexts outside of mathematics
- 4. Recognize that mathematics provides a precise system to describe objects, events, and relationships enabling the construction of logical arguments
- 5. Understand how the continued advancements of technology open new doors to the discovery of new mathematics and the development of current mathematics

Standard X**Representation**

-Create and use representations to organize, record, and communicate mathematical ideas
-Select, apply, and translate among mathematical representations to solve problems
-Use representations to model and interpret physical, social, and mathematical phenomena

- 1. The learner will be able to create and use

V: Data Analysis and Probability

Standard V Data Analysis and Probability - Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
- Select and use appropriate statistical methods to analyze data - Develop and evaluate inferences and predictions that are based on data - Understand and apply basic concepts of probability

- 1. Use double bar graphs to represent data [14]
- 2. Display and interpret data using pictographs, bar graphs and pie graphs [18]
- 3. Read and record data on coordinate graphs [21]
- 4. Create and interpret line graphs [4]
- 5. Group data appropriately and use stem-and-leaf plots to describe the data [4]
- 6. Recognize the effects of certain changes in data on its mean (e.g., by

V: Data Analysis and Probability

Standard V Data Analysis and Probability
□-Formulate Questions that can be addressed with data and collect, organize, and display relevant data to answer them
□-Select and use appropriate statistical methods to analyze data
□-Develop and evaluate inferences and predictions that are based on data
□-Understand and apply basic concepts of probability

- 1. Formulate questions, design studies, and collect data [7]
- 2. Select, draw, and compare graphical representations that are appropriate for the type of data collected (circle, bar, column, line plot, histogram, frequency table [11]
- 3. Find, use, and interpret measures of central tendency, including mean, median, mode and range [7]
- 4. Recognize faulty arguments, common errors, and misleading presentations of data in articles, advertisements, and other media [7]
- 5. Determine simple probability of independent events through experiments and simulations and express probabilities in a variety of ways

V: Data Analysis and Probability

Standard V Data Analysis - Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
- Select and use appropriate statistical methods to analyze data - Develop and evaluate inferences and predictions that are based on data - Understand and apply basic concepts of probability

- 1. Collect data using a variety of sampling methods (e.g., random, systematic, convenience, stratified, and voluntary) [1]
- 2. Analyze how decisions about graphing affect the graphical representation (e.g., scale, size of classes in a histogram, number of categories in a circle graph) [2]
- 3. Analyze a set of data by using and comparing combinations of measures of central tendency and range; describe how the inclusion or exclusion of outliers affects those measures [2]

V: Data Analysis and Probability

Standard V Data Analysis - Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
- Select and use appropriate statistical methods to analyze data - Develop and evaluate inferences and predictions that are based on data - Understand and apply basic concepts of probability

- 1. Select, create, and use appropriate graphical representations of data using scatter plots make conjectures about possible relationships between two characteristics of a sample on the basis of scatter plots of the data and approximate lines of fit [5]
- 2. Discuss and understand the correspondence between data sets and their graphical representations especially scatter plots [5]
- 3. Make conjectures about possible relationships between two characteristics of a sample on the

representation (manipulatives, computers, graphing calculators, pencil and paper) to organize, record, and communicate mathematical ideas

- 2. Select, apply, and translate among mathematical representations to solve problems
- 3. Use representations to model and interpret physical, social, and mathematical phenomena

Algebra 2

Standard I Number and Operations - Understand numbers, ways of representing numbers, relationships among numbers and number systems - Understand meanings of operations and how they relate to one another - Compute fluently and make reasonable estimates

- 1. Compute with rational and irrational numbers expressed in a variety of forms, including negative and fractional exponents and radicals [3]
- 2. Explain the meaning of n th root, and estimate the n th root of a given positive integer by locating it between consecutive integers (e.g., the 4th root of 50 is between 2 and 3)
- 3. Compute with complex numbers written in Cartesian form

Standard II Algebra - Understand patterns, relations, and functions - Represent and analyze mathematical situations and structures using algebraic symbols - Use mathematical models to represent and understand quantitative relationships - Analyze change in various contexts

- mean (e.g., by withdrawing one piece of data the mean will change) [4]
 - 7. Explore and collect data that relates to real world issues [8]
 - 8. Interpret data using mean, mode, median, maximum, minimum and range [12]
 - 9. Provide a percentage probability of an event occurring (e.g., 50% chance of rain today) [15]
- (e.g., fraction, percent, decimal) [6]
- 6. Make and test conjectures about the results of experiments and simulations [7]
- [4]
- 4. Compute probabilities of independent and dependent events using such methods as organized lists, tree diagrams and area models [6]
 - 5. Make predictions based on theoretical probabilities, design and conduct an experiment to test the predictions, compare actual results to predicted results, and explain differences [9]
- a sample on the basis of scatter plots of the data and approximate lines of fit [5]
- 4. Judge whether a sample is representative, depending on a number of factors (e.g., amount of data collected, what is known about the situation, how current data are) [5]
- 1. Define a "function" and to use and understand the $f(x)$ notation
 - 2. Describe and compare fundamental characteristics of the following functions: square root, cubic, absolute value (e.g., general shapes and symmetries of the graphs, zeros, domain and range)
 - 3. Describe and compare the fundamental characteristics of the following families of functions: quadratic, polynomial, exponential, logarithmic, and rational functions (e.g., general shapes and symmetries of the graphs, zeros, domain and range)
 - 4. Translate freely among tabular, graphical, and symbolic representations of functions
 - 5. Perform operations with compositions of functions
 - 6. Solve quadratic equations with real roots by factoring, graphing, completing the square, using the quadratic formula, and using technology [3]
 - 7. Find the maximum or minimum value of a quadratic function
 - 8. Perform operations on rational and radical expressions
 - 9. Solve equations involving rational and radical expressions, and to check for extraneous roots where appropriate
 - 10. Illustrate and apply the properties of exponential and

- logarithmic functions, including the inverse relationship between the two
- 11. Solve exponential and logarithmic equations
- 12. Solve real-world problems that can be modeled using systems of linear equations and inequalities
- 13. Solve real-world problems that can be modeled by linear, quadratic, square root, trigonometric, or exponential functions, including problems involving exponential growth/decay

Standard III Geometry
- Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems
- Apply transformations and use symmetry to analyze mathematical situations
- Use visualization, spatial reasoning, and geometric modeling to solve problems

- 1. Define and apply the basic trigonometric ratios in right triangles: sine, cosine, and tangent
- 2. Apply proportions and right triangle trigonometric ratios to solve problems involving missing lengths and angle measures in similar figures
- 3. Use trigonometric relationships to determine lengths and angle measures (e.g., using the Laws of Sines and Cosines)

to solve
triangles)

**Standard IV
Measurement -
Understand measurable
attributes of objects
and the units, systems,
and processes of
measurement - Apply
appropriate techniques,
tools, and formulas to
determine
measurements**

- 1. Determine the number of significant digits in a measurement and to round a given measurement to a specified number of significant digits
- 2. Translate freely between radian and degree measure and distinguish between their appropriate uses

**Standard V Data
Analysis and
Probability - Formulate
questions that can be
addressed with data
and collect, organize,
and display relevant
data to answer them -
Select and use
appropriate statistical
methods to analyze
data - Develop and
evaluate inferences and
predictions that are
based on data -
Understand and apply
basic concepts of
probability**

- 1. Display data using frequency distributions, histograms, box plots, and stem-and-leaf plots
- 2. Create a scatter plot of bivariate data, identify trends, and use technology to find a function to model the data
- 3. Make predictions using regression lines
- 4. Use technology to compute measures of central tendency (mean, median, and mode) and measures of spread (range, quartiles, and standard deviation) and interpret in the context of the

- problem
- 5. Use theoretical or experimental probability, including simulations, to determine probabilities in real-world problem situations

Standard VI Problem Solving - Build new mathematical knowledge through problem solving - Solve problems that arise in mathematics and in other contexts - Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving

- 1. Use a variety of problem-solving strategies relevant to the level of mathematics of the course and reflect on this process

Standard VII Reasoning and Proof - Recognize reasoning and proof as fundamental aspects of mathematics - Make and investigate mathematical conjectures - Develop and evaluate mathematical arguments and proofs - Select and use various types of reasoning and methods of proof

- 1. Recognize, understand, and develop the concept of mathematical proof as a fundamental aspect of mathematics at a level appropriate to the course

Standard VIII Communication - Organize and consolidate their mathematical thinking through communication - Communicate their mathematical thinking coherently and clearly to peers, teachers and others - Analyze and evaluate the mathematical thinking and strategies of others - Use the language of mathematics to express mathematical ideas

precisely

- 1. Organize, consolidate, analyze, and evaluate their mathematical thinking at a level appropriate to the level of the course [3]
- 2. Translate mathematical expressions into precise language for technology relevant to the level of the course
- 3. Translate verbal expressions into precise mathematical language

**Standard IX
Connections -
Recognize and use
connections among
mathematical ideas -
Understand how
mathematical ideas
interconnect and build
on one another to
produce a coherent
whole - Recognize and
apply mathematics in
contexts outside of
mathematics**

- 1. Recognize and use connections among mathematical ideas appropriate to the mathematical level of the course

**Standard X
Representation - Create
and use
representations to
organize, record, and
communicate
mathematical ideas -
Select, apply, and
translate among
mathematical
representations to
solve problems - Use
representations to
model and interpret
physical, social, and
mathematical
phenomena**

- 1. Create, use, select, apply, and translate mathematical representations appropriate to the level of the course [3]

VI: Problem Solving

VI: Problem Solving

VI: Problem Solving

Algebra 2 - Trigonometry

Standard VI: Problem Solving - Build new mathematical knowledge through problem solving - Solve problems that arise in mathematics and in other contexts - Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving	Standard VI Problem Solving - Build new mathematical knowledge through problem solving - Solve problems that arise in mathematics and in other contexts - Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving	Standard VI Problem Solving - Build new mathematical knowledge through problem solving - Solve problems that arise in mathematics and in other contexts Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving	Standard I Number and Operations - Understand numbers, ways of representing numbers, relationships among numbers and number systems - Understand meanings of operations and how they relate to one another - Compute fluently and make reasonable estimates <ul style="list-style-type: none"> 1. Compute fluently with rational and irrational numbers expressed in a variety of forms, including negative and fractional exponents and radicals [4] 2. Explain the meaning of nth root, and estimate the nth root of a given positive integer by locating it between consecutive integers (e.g., the 4th root of 50 is between 2 and 3) [6] 3. Compute fluently with complex numbers written in Cartesian form [2] 4. Explain the relationships between different sets of numbers (i.e., the complex, real, rational, irrational numbers, and the integers) [8] 5. Expand powers of binomials using the Binomial Theorem 6. Recognize, represent, and analyze arithmetic and geometric sequences and series [2] 7. Use summation notation to represent the sum of a sequence, and to illustrate the basic properties of this notation [2]
<ul style="list-style-type: none"> 1. Build new mathematical knowledge through regular problem solving, including content and supplementary activities 2. Solve problems that arise in mathematics and in other contexts [12] 3. Develop and apply strategies to a wide variety of problems, i.e. applying logical reasoning, use of manipulatives, identifying patterns, guess, check, and revise, work backwards, draw picture, table, diagram 4. Monitor and reflect on the process of problem solving (i.e., identifying extraneous information, estimating solutions for problems, determining the reasonableness of a solution by comparing it to an estimate, choosing an appropriate calculation method) 5. Formulate problems from everyday and mathematical situations [12] 	<ul style="list-style-type: none"> 1. Build new mathematical knowledge through regular problem solving, including content and supplementary activities [12] 2. Solve problems that arise in mathematics and in other contexts [11] 3. Develop and apply strategies to a wide variety of problems, i.e. applying logical reasoning, use of manipulatives, identifying patterns, guess, check, and revise, work backwards, draw picture, table, diagram [12] 4. Monitor and reflect on the process of problem solving (i.e., identifying extraneous information, estimating solutions for problems, determining the reasonableness of a solution by comparing it to an estimate, choosing an appropriate calculation method) [8] 5. Formulate problems from everyday and mathematical situations [8] 	<ul style="list-style-type: none"> 1. Build new mathematical knowledge through problem solving [13] 2. Solve problems that arise in mathematics and in other contexts [26] 3. Develop and apply strategies to a wide variety of problems, i.e. applying logical reasoning, use of manipulatives, identifying patterns, guess, check, and revise, work backwards, draw picture, table, diagram [13] 4. Monitor and reflect on the process of problem solving (i.e., identifying extraneous information, estimating solutions for problems, determining the reasonableness of a solution by comparing it to an estimate, choosing an appropriate calculation method) [4] 5. Formulate problems from everyday and mathematical situations [21] 	Standard II Algebra - Understand patterns, relations, and functions - Represent and analyze mathematical

situations and structures using algebraic symbols - Use mathematical models to represent and understand quantitative relationships - Analyze change in various contexts

- 1. Define a "function" and to use and understand the $f(x)$ notation
[10]
- 2. Describe and compare fundamental characteristics of the following functions: square root, cubic, absolute value, and basic trigonometric functions (e.g., general shapes and symmetries of the graphs, zeros, domain and range, inverses)
[3]
- 3. Describe and compare the fundamental characteristics of the following families of functions: quadratic, polynomial, exponential, logarithmic, and rational functions (e.g., general shapes and symmetries of the graphs, zeros, domain and range, inverses)
[6]
- 4. Translate freely among tabular, graphical, and symbolic representations of functions
[10]
- 5. Perform operations with compositions of functions
[2]
- 6. Represent the inverse of a function using tabular, graphical, and (for certain families of functions) symbolic representations
[2]
- 7. Solve 3×3 systems of linear equations by elimination
- 8. Solve quadratic equations over

the complex numbers by factoring, graphing, completing the square, using the quadratic formula, and using technology [2]

- 9. Find the maximum or minimum value of a quadratic function [2]
- 10. Perform operations on rational and radical expressions [4]
- 11. Solve equations involving rational and radical expressions, and to check for extraneous roots where appropriate [4]
- 12. Illustrate and apply the properties of exponential and logarithmic functions, including the inverse relationship between the two [2]
- 13. Solve exponential and logarithmic equations [2]
- 14. Solve real-world problems that can be modeled using systems of linear equations and inequalities [8]
- 15. Solve real-world problems that can be modeled by linear, quadratic, square root, trigonometric, or exponential functions, including problems involving exponential growth/decay [18]
- 16. Apply division of polynomials (long division and synthetic division) to determine factors and remainders [4]
- 17. Derive and apply the basic

trigonometric identities, including the Pythagorean identities
[1]

Standard III Geometry - Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships - Specify locations and describe spatial relationships using coordinate geometry and other representational systems - Apply transformations and use symmetry to analyze mathematical situations - Use visualization, spatial reasoning, and geometric modeling to solve problems

- 1. Use trigonometric relationships to determine lengths and angle measures (e.g., using the Laws of Sines and Cosines to solve triangles)
[2]

Standard IV Measurement - Understand measurable attributes of objects and the units, systems, and processes of measurement - Apply appropriate techniques, tools, and formulas to determine measurements

- 1. Determine the number of significant digits in a measurement and to round a given measurement to a specified number of significant digits
[3]
- 2. Translate freely between radian and degree measure and distinguish between their appropriate uses
[1]

Standard V Data Analysis and Probability - Formulate questions that can be addressed with data and collect,

organize, and display relevant data to answer them

- **Select and use appropriate statistical methods to analyze data**
- **Develop and evaluate inferences and predictions that are based on data**
- **Understand and apply basic concepts of probability**

- 1. Create a scatter plot of bivariate data, identify trends, and use technology to find a function to model the data [1]
- 2. Use technology to find the least-squares regression line and the correlation coefficient for bivariate data with a linear trend and interpret each of these statistics in the context of the given problem [1]
- 3. Transform bivariate data so that it can be modeled by a function of a given type (e.g., use logarithms to transform nonlinear data into data more closely approximated by linear regression) [1]
- 4. Use technology to compute measures of central tendency (mean, median, and mode) and measures of spread (range, quartiles, and standard deviation) and interpret in the context of the problem [2]
- 5. Describe the standard normal curve and its general properties, and answer questions about with data assumed to be sampled from a normal distribution [1]
- 6. Analyze and interpret

univariate and bivariate data to identify patterns, note trends, draw conclusions, and make predictions
[1]

- 7. Use theoretical or experimental probability, including simulations, to determine probabilities in real-world problem situations
[1]
- 8. Understand and be able to apply the concepts of mutually exclusive, complementary, and independent events to probabilistic or statistical problems
[1]
- 9. Understand and be able to apply the concept of conditional probability
[1]
- 10. Construct and interpret confidence intervals computed from random samples

Standard VI Problem Solving - Build new mathematical knowledge through problem solving - Solve problems that arise in mathematics and in other contexts - Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving

- 1. Use a variety of problem-solving strategies relevant to the level of mathematics of the course and reflect on this
[26]

Standard VII Reasoning and Proof - Recognize reasoning and proof as fundamental aspects of mathematics - Make and investigate mathematical conjectures - Develop and evaluate mathematical arguments and proofs - Select and use various

types of reasoning and methods of proof

- 1. Recognize, understand, and develop the concept of mathematical proof as a fundamental aspect of mathematics at a level appropriate to the course
[3]

Standard VIII
Communication -
Organize and consolidate their mathematical thinking through communication
- Communicate their mathematical thinking coherently and clearly to peers, teachers and others - Analyze and evaluate the mathematical thinking and strategies of others
- Use the language of mathematics to express mathematical ideas precisely

- 1. Organize, consolidate, analyze, and evaluate their mathematical thinking at a level appropriate to the level of the course
[25]
- 2. Translate mathematical expressions into precise language for technology relevant to the level of the course
[25]
- 3. Translate verbal expressions into precise mathematical language to the level of the course
[25]

Standard IX
Connections -
Recognize and use connections among mathematical ideas -
Understand how mathematical ideas interconnect and build on one another to produce a coherent whole - Recognize and apply mathematics in contexts outside of mathematics

- 1. Recognize and use connections among

mathematical ideas appropriate to the mathematical level of the course
[27]

Standard X
Representation - Create and use representations to organize, record, and communicate mathematical ideas - Select, apply, and translate among mathematical representations to solve problems - Use representations to model and interpret physical, social, and mathematical phenomena

- 1. Create, use, select, apply, and translate mathematical representations appropriate to the level of the course
[27]

VII: Reasoning and Proof

Standard VII: Reasoning and Proof
- Recognize reasoning and proof as fundamental aspects of mathematics
- Make and investigate mathematical conjectures
- Develop and evaluate mathematical arguments and proofs
- Select and use various types of reasoning and methods of proof

- 1. Make and investigate mathematical conjectures and explore these conjectures
[7]
- 2. Recognize, understand and develop the concept of a mathematical proof
[6]

VII: Reasoning and Proof

Standard VII Reasoning and Proof
- Recognize reasoning and proof as fundamental aspects of mathematics - Make and investigate mathematical conjectures - Develop and evaluate mathematical arguments and proofs
- Select and use various types of reasoning and methods of proof

- 1. Make and investigate mathematical conjectures and explore these conjectures
- 2. Recognize, understand and develop the concept of a mathematical proof

VII: Reasoning and Proof

Standard VII Reasoning and Proof
- Recognize reasoning and proof as fundamental aspects of mathematics - Make and investigate mathematical conjectures - Develop and evaluate mathematical arguments and proofs
- Select and use various types of reasoning and methods of proof

- 1. Make and investigate mathematical conjectures of explore these conjectures
[8]
- 2. Recognize, understand and develop the concept of a mathematical proof as fundamental aspects of mathematics
[2]
- 3. Select and use various types of reasoning and methods of proof
[2]

Geometry

Standard I Number and Operations - Understand numbers, ways of representing numbers, relationships among numbers and number systems - Understand meanings of operations and how they relate to one another - Compute fluently and make reasonable estimates

- 1. Make connections between verbal and symbolic representations of irrational numbers (i.e., the hypotenuse and the Pythagorean Theorem)
[5]
- 2. Compute fluently and make reasonable estimates, for instance for areas and volumes
[10]
- 3. Perform operations on and simplify expressions involving radicals
- 4. Compute with rational and irrational numbers expressed in a variety of forms. Explain the meaning of nth

root, and estimate the n th root of a given positive integer by locating it between consecutive integers (e.g., the 4th root of 50 is between 2 and 3)

Standard II Algebra - Understand patterns, relations, and functions - Represent and analyze mathematical situations and structures using algebraic symbols - Use mathematical models to represent and understand quantitative relationships - Analyze change in various contexts

- 1. Analyze patterns and sequences, especially those that pertain to geometric patterns [10]
- 2. Model and solve real-life situations using linear (equations and inequalities), quadratic and exponential models through tables, graphs and algebraic representations
- 3. Write and use equivalent forms of equations (such as writing linear equations in slope-intercept form.)
- 4. Recognize and explain that the slopes of parallel lines are equal and the slopes of perpendicular lines are negative reciprocals
- 5. Solve systems of linear equations and inequalities using graphs, substitution, and elimination
- 6. Perform operations on algebraic expressions involving monomials and polynomials
- 7. Transpose equations for a specified variable given more than one variable
- 8. Simplify and perform operations on

- rational expressions, and solve rational equations
- 9. Solve multi-step linear equations using a variety of methods.
- 10. Solve real-world problems that can be modeled using systems of linear equations

Standard III Geometry
- Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems
- Apply transformations and use symmetry to analyze mathematical situations
- Use visualization, spatial reasoning, and geometric modeling to solve problems

- 1. Define and explain key aspects of geometric figures, including:
 - a) Interior and exterior angles of polygons
 - b) Segments related to triangles (median, altitude, mid-segment)
 - c) Points of concurrency related to triangles (centroid, incenter, orthocenter, circumcenter)
 - d) Circles (radius, diameter, chord, circumference, major arc, minor arc, sector, segment, inscribed angle)
 [[25](#)]
- 2. Identify the angles formed and apply the relationships between the angles formed either by two intersecting lines or by parallel lines cut by a transversal
 [[5](#)]
- 3. Use

proportions to solve problems involving similar figures

[5]

- 4. Define and apply the basic trigonometric ratios in right triangles: sine, cosine, and tangent
[5]
- 5. Apply proportions and right triangle trigonometric ratios to solve problems involving missing lengths and angle measures in similar figures
[5]
- 6. Explain the necessity for certain terms to remain undefined, such as point, line and plane
[5]
- 7. Represent and analyze shapes using coordinate geometry (e.g., given three vertices and the type of quadrilateral, find the coordinates of the fourth vertex; or use distance and/or slope to show that a quadrilateral is a parallelogram)
[10]
- 8. Construct right triangles, equilateral triangles, parallelograms, trapezoids, rectangles, rhombuses, squares and kites, using compass and straightedge or dynamic geometry software
[5]
- 9. Construct congruent figures using tools, such as compass, straightedge, and protractor or dynamic geometry software
[5]
- 10. Perform translations, reflections, rotations, and dilations of twodimensional figures using a variety of

- methods (e.g., paper folding, tracing, coordinate geometry, with construction)
[3]
- 11. Identify the properties of a geometric figure that remain fixed under various transformations (e.g., lengths of sides remain the same under translations)
[3]
 - 12. Describe and display the results of combinations of translations, reflections and rotations (compositions), (e.g., perform compositions and specify the result of a composition as the outcome of a single motion, when applicable)
[8]
 - 13. Represent three-dimensional geometric objects two-dimensionally (e.g., using nets, orthogonal drawing or isometric drawing)
[10]
 - 14. Solve problems involving chords, radii, tangents and arcs of a circle
 - 15. Model and solve real-world problems using the Pythagorean theorem
 - 16. Demonstrate and apply the relationship between the Pythagorean theorem and the distance formula
 - 17. Use graphical and algebraic methods to solve problems involving distance, midpoint, and slope
 - 18. Transform basic functions on a coordinate plane.
 - 19. Use trigonometric relationships to determine lengths and angle

measures (e.g.,
using the Laws of
Sines and Cosines
to solve
triangles)

**Standard IV
Measurement -
Understand measurable
attributes of objects
and the units, systems,
and processes of
measurement - Apply
appropriate techniques,
tools, and formulas to
determine
measurements**

- 1. Convert from one unit to another both between and within systems [45]
- 2. Explain and apply strategies to find the area of composite shapes using area of triangles, parallelograms, circles and sectors
- 3. Explain the difference between surface area and volume and demonstrate that two objects may have the same surface area, but two different volumes, or may have the same volume, but different surface areas [10]
- 4. Analyze changes to related measures when one or more dimensions of a geometric figure are changed (e.g., length of sides are doubled) [5]
- 5. Derive formulas for surface area and volume and justify them using geometric models and common materials. For example, find: a) The surface area of a cylinder as a function of its height and radius b) That the volume of a pyramid (or cone) is one-third of the volume of a prism (or cylinder) with the same base area

- and height
[15]
- 6. Solve problems involving the interior and exterior angles of convex polygons
[10]
 - 7. Use conventional formulas to find the surface area and volume of prisms, pyramids, cylinders, and spheres and the volume of cones to a specified level of precision including the surface area of a cone as a function of its slant height and the circumference of its base
[15]
 - 8. Demonstrate understanding of the concepts of perimeter, circumference and area by using established formulae for triangles, quadrilaterals, circles and polygons
[15]
 - 9. Use the ratio of lengths in similar two-dimensional figures or threedimensional objects to calculate the ratio of their areas or volumes respectively
 - 10. Use scale drawings and right triangle trigonometry to solve problems that include unknown distances and angle measures
 - 11. Determine the measures of central and inscribed angles and their associated major and minor arcs
[5]
 - 12. Calculate lengths, areas, surface areas, and volumes of composite three-dimensional objects to a specified level of precision
[15]
 - 13. Solve real-world problems involving area, surface area,

volume and density to a specified level of precision [15]

- 14. Describe relationships among units and convert from one unit to another within the same system
- 15. Solve simple problems involving rates and derived measurements for such attributes as velocity and density
- 16. Check solutions to problems for reasonable results in context
- 17. Determine the number of significant digits in a measurement and to round a given
- 18. Translate freely between radian and degree measure and distinguish between their appropriate uses (TP)

Standard V Data Analysis and Probability

– **Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them**

– **Select and use appropriate statistical methods to analyze data**

– **Develop and evaluate inferences and predictions that are based on data**

– **Understand and apply basic concepts of probability**

- 1. Use technology to compute measures of central tendency (mean, median, and mode) and measures of spread (range, quartiles, and standard deviation) and interpret in the context of the problem (TP)

Standard VI Problem Solving - Build new mathematical knowledge through problem solving - Solve

problems that arise in mathematics and in other contexts - Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving

- 1. Use a variety of problem-solving strategies relevant to the level of mathematics of the course and reflect on this process
[10]

Standard VII Reasoning and Proof - Recognize reasoning and proof as fundamental aspects of mathematics - Make and investigate mathematical conjectures - Develop and evaluate mathematical arguments and proofs - Select and use various types of reasoning and methods of proof

- 1. Recognize, understand, and develop the concept of mathematical proof as a fundamental aspect of mathematics at a level appropriate to the course
[55]
- 2. The learner will be able to select and use various types of reasoning and methods of proof
[10]
- 3. Make, test, and establish the validity of conjectures about geometric properties and relationships using counterexample, inductive and deductive reasoning, and paragraph or two-column proof and constructions (patty/tracing paper, compass, and Geometric sketchpad)
[5]

Standard VIII Communication - Organize and consolidate their mathematical thinking

through communication
- Communicate their mathematical thinking coherently and clearly to peers, teachers and others
- Analyze and evaluate the mathematical thinking and strategies of others
- Use the language of mathematics to express mathematical ideas precisely

- 1. Organize, consolidate, analyze, and evaluate their mathematical thinking at a level appropriate to the level of the course
[55]
- 2. Translate mathematical expressions into precise language for technology relevant to the level of the course
[50]
- 3. Translate verbal expressions into precise mathematical language to the level of the course
[45]

Standard IX
Connections -
Recognize and use connections among mathematical ideas -
Understand how mathematical ideas interconnect and build on one another to produce a coherent whole - Recognize and apply mathematics in contexts outside of mathematics

- 1. Recognize and use connections among mathematical ideas appropriate to the mathematical level of the course
[50]

Standard X
Representation - Create and use representations to organize, record, and communicate mathematical ideas -
Select, apply, and translate among mathematical representations to solve problems - Use representations to

model and interpret physical, social, and mathematical phenomena

- 1. Create, use, select, apply, and translate mathematical representations appropriate to the level of the course [55]

VIII. Communication

Standard VIII: Communication
- Organize and consolidate their mathematical thinking through communication
- Communicate their mathematical thinking coherently and clearly to peers, teachers and others
- Analyze and evaluate the mathematical thinking and strategies of others
- Use the language of mathematics to express mathematical ideas precisely

- 1. Organize and consolidate their mathematical thinking through communication [8]
- 2. Communicate their mathematical thinking coherently and clearly to peers, teachers, and others [10]
- 3. Analyze and evaluate the mathematical thinking and strategies of others [8]
- 4. Use the language of mathematics to express the mathematical ideas precisely [6]
- 5. Translate mathematical expressions into precise language for technology [2]

VIII. Communication

Standard VIII: Communication
- Organize and consolidate their mathematical thinking through communication
- Communicate their mathematical thinking coherently and clearly to peers, teachers and others
- Analyze and evaluate the mathematical thinking and strategies of others
- Use the language of mathematics to express mathematical ideas precisely

- 1. Organize and consolidate their mathematical thinking through communication [6]
- 2. Communicate their mathematical thinking coherently and clearly to peers, teachers, and others [9]
- 3. Analyze and evaluate the mathematical thinking and strategies of others [10]
- 4. Use the language of mathematics to express the mathematical ideas precisely [3]
- 5. Translate mathematical expressions into precise language for technology

VIII. Communication

Standard VIII: Communication
- Organize and consolidate their mathematical thinking through communication
- Communicate their mathematical thinking coherently and clearly to peers, teachers and others
- Analyze and evaluate the mathematical thinking and strategies of others
- Use the language of mathematics to express mathematical ideas precisely

- 1. Organize and consolidate their mathematical thinking through communication [10]
- 2. Communicate their mathematical thinking coherently and clearly to peers, teachers and others [4]
- 3. Analyze and evaluate the mathematical thinking and strategies of others [7]
- 4. Use the language of mathematics to express mathematical ideas precisely [13]
- 5. Translate mathematical expressions into precise language for technology [8]

AP Calculus

Standard I Number and Operations
- Understand numbers, ways of representing numbers, relationships among numbers and number systems
- Understand meanings of operations and how they relate to one another
- Compute fluently and make reasonable estimates

- 1. Analyze sequences and series of real numbers (BC)

Standard II Algebra
- Understand patterns, relations, and functions
- Represent and analyze mathematical situations and structures using algebraic symbols
- Use mathematical models to represent and understand quantitative relationships
- Analyze change in various contexts

- 1. Analyze and apply functions given by parametric equations (BC) [2]
- 2. Analyze and apply functions given by polar equations (BC)

Standard III Geometry
- Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems
- Apply transformations and use symmetry to analyze mathematical situations
- Use visualization, spatial

**reasoning, and
geometric modeling to
solve problems**

- 1. Use the derivative to compute the slope of tangent lines (AB, BC)
[20]
- 2. Apply integration to compute areas (AB, BC)
[16]
- 3. Apply integration to calculate volumes of revolution (AB, BC)
[8]
- 4. Apply integration to compute volumes of solids with known cross sections (AB, BC)
[8]

**Standard IV
Measurement -
Understand measurable
attributes of objects
and the units, systems,
and processes of
measurement - Apply
appropriate techniques,
tools, and formulas to
determine
measurements**

- 1. Interpret the results of differentiation and integration using correct units (AB, BC)
[34]

**Standard V Data
Analysis and
Probability - Formulate
questions that can be
addressed with data
and collect, organize,
and display relevant
data to answer them -
Select and use
appropriate statistical
methods to analyze
data - Develop and
evaluate inferences and
predictions that are
based on data -
Understand and apply
basic concepts of
probability Analysis -
Analyze the
mathematics of change
using differential
calculus - Analyze the
mathematics of
accumulation using
integral calculus**

- 1. Analyze the asymptotic behavior of functions using the concept of limit (AB, BC)
[16]

- 2. Define and interpret (slope of tangent line) the derivative of a function using limits (AB, BC) [20]
- 3. Interpret the derivative in terms of rate of change and local linear approximation and be able to use derivatives to solve a variety of problems (AB, BC) [16]
- 4. Develop and apply rules of differentiation for common algebraic and transcendental functions (AB, BC) [14]
- 5. Differentiate more complex functions using the Product, Quotient, and Chain Rules for the derivative (AB, BC) [16]
- 6. Apply implicit differentiation to compute derivatives of implicitly defined functions (AB, BC) [16]
- 7. Interpret and apply the derivative to solve problems involving rates of change (AB, BC) [10]
- 8. Interpret and apply the derivative to solve optimization problems (AB, BC) [10]
- 9. Analyze higher rates of change (e.g. acceleration) and the geometry of concavity using the second derivative (AB, BC) [12]
- 10. Use the first and second derivatives to analyze the local and global behavior of functions (AB, BC) [12]
- 11. Use higher-order derivatives to obtain

- polynomial approximations to differentiable functions (BC)
- 12. Use L'Hôpital's Rule to compute limits of indeterminate forms (AB, BC) [4]
 - 13. Understand and apply the antiderivative (indefinite integral) as the inverse of the derivative (AB, BC) [20]
 - 14. Understand the meaning of the definite integral both as a limit of Riemann sums and as the net accumulation of change, and use integrals to solve a variety of problems (AB, BC) [22]
 - 15. Understand the relationship between the derivative and the definite integral as expressed in both parts of the Fundamental Theorem of Calculus (AB, BC) [18]
 - 16. Compute numerical approximations of definite integrals (AB, BC) [16]
 - 17. Compute antiderivatives of basic algebraic and transcendental functions (AB, BC) [20]
 - 18. Develop and apply techniques of integration, u-substitution, integration by parts, and integration by partial fractions (AB, BC) [22]
 - 19. Understand and compute improper integrals (AB, BC) [4]
 - 20. Apply differential and integral calculus to problems of kinematics (AB, BC) [34]
 - 21. Solve separable first-

order differential equations by separation of variables (AB, BC)
[16]

- 22. Represent solutions of first-order differential equations through their slope fields (AB, BC)
[10]
- 23. Find numerical solutions to first-order differential equations (Euler's Method) (AB, BC)
[4]
- 24. Analyze the convergence or divergence of infinite series using a variety of tests (comparison, limit comparison, p-series, and ratio tests) (BC)
- 25. Compute the radius of convergence of a power series (BC)
- 26. Manipulate power series of familiar functions to obtain new power series (BC)
- 27. Apply the Lagrange Error Bound for Taylor polynomials (BC)
- 28. Apply differential and integral calculus to functions represented in parametric or polar form (BC)
- 29. Compute the velocity vector and the acceleration vector of a particle whose motion is given by parametric equations (BC)

Standard VI Problem Solving - Build new mathematical knowledge through problem solving - Solve problems that arise in mathematics and in other contexts - Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving

- 1. Use a variety of problem-solving strategies relevant to the level of mathematics of

the course and
reflect on this
process
[46]

- 2. Model a written description of a physical situation with a function, a differential equation, or an integral (AB, BC)
[36]
- 3. Use technology to help solve problems, experiment, interpret results, and verify conclusions (AB, BC)
[44]
- 4. Determine the reasonableness of solutions, including sign, size, relative accuracy, and units of measurement (AB, BC)
[46]

Standard VII Reasoning and Proof - Recognize reasoning and proof as fundamental aspects of mathematics - Make and investigate mathematical conjectures - Develop and evaluate mathematical arguments and proofs - Select and use various types of reasoning and methods of proof

- 1. Recognize, understand, and develop the concept of mathematical proof as a fundamental aspect of mathematics at a level appropriate to the course
[8]

Standard VIII Communication - Organize and consolidate their mathematical thinking through communication - Communicate their mathematical thinking coherently and clearly to peers, teachers and others - Analyze and evaluate the mathematical thinking and strategies of others - Use the language of mathematics to express mathematical ideas precisely

- 1. Organize, consolidate, analyze, and

evaluate their mathematical thinking at a level appropriate to the level of the course
[46]

- 2. Translate mathematical expressions into precise language for technology relevant to the level of the course
[46]
- 3. Translate verbal expressions into precise mathematical language to the level of the course
[46]

**Standard IX
Connections -
Recognize and use
connections among
mathematical ideas -
Understand how
mathematical ideas
interconnect and build
on one another to
produce a coherent
whole - Recognize and
apply mathematics in
contexts outside of
mathematics**

- 1. Recognize and use connections among mathematical ideas appropriate to the mathematical level of the course
[46]

**Standard X
Representation - Create
and use
representations to
organize, record, and
communicate
mathematical ideas -
Select, apply, and
translate among
mathematical
representations to
solve problems - Use
representations to
model and interpret
physical, social, and
mathematical
phenomena**

- 1. Create, use, select, apply, and translate mathematical representations appropriate to the level of the course
[46]
- 2. Work with functions represented in a

variety of ways:
graphical,
numerical,
analytical, or
verbal, and
understand the
connections
among these
representations
(AB, BC)
[46]

IX. Connections

Standard IX: Connections
- Recognize and use connections among mathematical ideas
- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
- Recognize and apply mathematics in contexts outside of mathematics

- 1. Recognize and use connections among mathematical ideas [6]
- 2. Understand connections between equivalent representations and corresponding procedures of the same problem situation or mathematical concept [6]
- 3. Recognize and apply mathematics in contexts outside of mathematics [7]
- 4. Recognize that mathematics provides a precise system to describe objects, events, and relationships enabling the construction of logical arguments [2]
- 5. Understand how the continued advancements of technology open new doors to the discovery of new mathematics and the development of current mathematics [7]

IX. Connections

Standard IX: Connections
- Recognize and use connections among mathematical ideas - Understand how mathematical ideas interconnect and build on one another to produce a coherent whole - Recognize and apply mathematics in contexts outside of mathematics

- 1. Recognize and use connections among mathematical ideas [9]
- 2. Understand connections between equivalent representations and corresponding procedures of the same problem situation or mathematical concept [9]
- 3. Recognize and apply mathematics in contexts outside of mathematics [10]
- 4. Recognize that mathematics provides a precise system to describe objects, events, and relationships enabling the construction of logical arguments
- 5. Understand how the continued advancements of technology open new doors to the discovery of new mathematics and the development of

IX. Connections AP Statistics

Standard IX: Connections
- Recognize and use connections among mathematical ideas - Understand how mathematical ideas interconnect and build on one another to produce a coherent whole - Recognize and apply mathematics in contexts outside of mathematics

- 1. Recognize and use connections among mathematical ideas [10]
- 2. Understand connections between equivalent representations and corresponding procedures of the same problem situation or mathematical concept [10]
- 3. Recognize and apply mathematics in contexts outside of mathematics [18]
- 4. Recognize that mathematics provides a precise system to describe objects, events, and relationships enabling the construction of logical arguments [18]
- 5. Understand how the continued advancements of technology open new doors to the discovery of new mathematics and the development of current mathematics [5]

Standard III Algebra - Understand patterns, relations, and functions
- Represent and analyze mathematical situations and structures using algebraic symbols - Use mathematical models to represent and understand quantitative relationships - Analyze change in various contexts

- 1. Apply transformations to linearize non-linear data [2]

Standard IV: Measurement - Understand measurable attributes of objects and the units, systems, and processes of measurement - Apply appropriate techniques, tools, and formulas to determine measurements

- 1. Understand the meaning and attributes of a sample's statistics, especially the standard deviation, correlation coefficient, z-score, and p-value of a sample [8]

Standard V Data Analysis and Probability - Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them - Select and use appropriate statistical methods to analyze data - Develop and evaluate inferences and predictions that are based on data - Understand and apply basic concepts of probability

- 1. Compute sample statistics such as the

current
mathematics
[1]

- correlation coefficient, mean, standard deviation and determine their reasonableness [4]
- 2. Interpret graphical displays of distributions of univariate data (boxplot, dotplot, stemplot, histogram, and cumulative frequency plot) and specifically describe the distributions according to shape, center and spread, clusters and gaps, outliers and other unusual features [5]
 - 3. Summarize distributions of univariate data using median and mean as measures of center; range, interquartile range, standard deviation as measures of spread; quartiles, percentiles, standardized scores (z-scores) as measures of position [3]
 - 4. Compare distributions of univariate data (back-to-back stemplots, parallel boxplots); this will include comparing center and spread: within group, between group variation; comparing clusters and gaps; comparing outliers and other unusual features; and comparing shapes [3]
 - 5. Explore bivariate data by analyzing patterns in scatterplots, measuring and interpreting correlation and linearity, finding least squares regression line and exploring and interpreting residual plots, outliers, and influential points

- [5]
- 6. Explore categorical data in the form of frequency tables and compute marginal and joint frequencies for one- and two-way tables and conditional relative frequencies and association [4]
- 7. Understand probability as relative frequency including the "Law of Large Numbers" [4]
- 8. Apply the addition rule, multiplication rule, conditional probabilities, and independence in specific computations of probabilities [4]
- 9. Identify discrete random variables and their probability distributions, including the binomial distribution, and compute the expected value and standard deviation of a discrete random variable, and linear transformations thereof [2]
- 10. Perform simulation of probability distributions, including the binomial and geometric distributions [5]
- 11. Use properties of statistics for combining independent random variables distinguishing between dependent and independent events
- 12. Find the mean and standard deviation for sums and differences of independent random variables [4]
- 13. Use tables of the normal

distribution, and also be able to find those same table values on a graphing calculator

[4]

- 14. Understand the sampling distribution of a sample proportion, the sampling distribution of a sample mean, the sampling distribution of a difference between two independent sample proportions, and the sampling distribution of a difference between two independent sample means [5]
- 15. Compute the probability of a Type I error in hypothesis testing [5]
- 16. Use a random digit generator or random number table to create simulations of sampling distributions [6]

Standard VI Problem Solving - Build new mathematical knowledge through problem solving - Solve problems that arise in mathematics and in other contexts - Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving

- 1. Decide on the appropriate sample statistics to use in order to build confidence intervals for a proportion, for a mean, for a difference between two proportions, and for a difference between two means (unpaired and paired) in situations in which the samples are small, or large enough to allow for the approximation with the normal

distribution

[3]

- 2. When making inferences, decide on the appropriate statistical test to use, propose null and alternative hypotheses, distinguish between one and two-sided tests, compute appropriate test statistics, and come to a conclusion, interpreting the results
[2]
- 3. Discern situations in which the conditions for using hypothesis testing are met and when such tests are not justified
[3]

**Standard VIII
Communication -
Organize and
consolidate their
mathematical thinking
through communication
- Communicate their
mathematical thinking
coherently and clearly
to peers, teachers and
others - Analyze and
evaluate the
mathematical thinking
and strategies of others
- Use the language of
mathematics to express
mathematical ideas
precisely**

- 1. Describe, compare, and contrast different methods of data collection including the census, sample surveys, experiments, and observational studies
[2]
- 2. Explain the reasoning behind well-designed and well-conducted surveys, especially the reasons behind and possible improvements on examples of poorly-designed surveys
[2]
- 3. Explain possible sources and implications of bias in sample selection, and

ways to minimize bias, in simple random sampling and stratified random sampling [2]

- 4. Explain the reasoning behind well-designed and well-conducted experiments, especially the reasons behind and possible improvements on examples of poorly-designed experiments; lay out and describe the components of experiments in the context of a problem, including treatments, control groups, experimental units, random assignments, replication, sources of bias and confounding, including placebo effect and blinding, in completely randomized designs and randomized block designs (including matched pairs designs) [2]
- 5. Explain whether results from observational studies, experimental studies, and surveys can be generalized to corresponding statements about the corresponding population [2]
- 6. Explain Type I, Type II errors, and Power and their consequences in relation to significance testing in the context of a problem [2]
- 7. Discuss the consequences of the Central Limit Theorem to sampling distributions [2]

**Standard IX
Connections -
Recognize and use
connections among
mathematical ideas -**

Understand how mathematical ideas interconnect and build on one another to produce a coherent whole - Recognize and apply mathematics in contexts outside of mathematics

- 1. Synthesize all the topics learned in order to plan and carry out a statistical study: collecting data, computing and presenting relevant summaries and calculations, and coming to a conclusion, interpreting the results in context of the problem [9]

**Standard VII
Representation - Create and use representations to organize, record, and communicate mathematical ideas - Select, apply, and translate among mathematical representations to solve problems - Use representations to model and interpret physical, social, and mathematical phenomena**

- 1. Use simulations to represent sampling from a given distribution [10]

X. Representation

**Standard X:
Representation**
- Create and use representations to organize, record, and communicate mathematical ideas
- Select, apply, and translate among mathematical representations to solve problems
- Use representations to model and interpret physical, social, and mathematical phenomena

- 1. The learner will be able to create and use representation (manipulatives, computers, graphing calculators, pencil and paper) to organize, record, and communicate mathematical ideas [2]

X. Representation

**Standard X
Representation**
- Create and use representations to organize, record, and communicate mathematical ideas
- Select, apply, and translate among mathematical representations to solve problems
- Use representations to model and interpret physical, social, and mathematical phenomena

- 1. The learner will be able to create and use representation (manipulatives, computers, graphing calculators, pencil and

X. Representation

**Standard X
Representation**
- Create and use representations to organize, record, and communicate mathematical ideas
- Select, apply, and translate among mathematical representations to solve problems
- Use representations to model and interpret physical, social, and mathematical phenomena

- 1. The learner will be able to create and use representation (manipulatives, computers, graphing calculators, pencil and

IB Mathematics

Standard I Number and Operations - Understand numbers, ways of representing numbers, relationships among numbers and number systems - Understand meanings of operations and how they relate to one another - Compute fluently and make reasonable estimates

- 1. Illustrate which properties hold for vector addition and scalar multiplication (HL, SL) [6]
- 2. Illustrate which properties hold for addition and multiplication of matrices (HL, SL) [6]

- 2. Select, apply, and translate among mathematical representations to solve problems
 - 3. Use representations to model and interpret physical, social, and mathematical phenomena [4]
- pen and paper) to organize, record, and communicate mathematical ideas [5]
- 2. Select, apply, and translate among mathematical representations to solve problems
 - 3. Use representations to model and interpret physical, social, and mathematical phenomena
- pen and paper) to organize, record, and communicate mathematical ideas [18]
- 2. Select, apply, and translate among mathematical representations to solve problems [13]
 - 3. Use representations to model and interpret physical, social, and mathematical phenomena [19]
- 3. Model using the coordinate plane, vector addition, and scalar multiplication (HL, SL) [6]
 - 4. Calculate the dot product (2D and 3D) and cross product (3D) of two vectors (HL, SL) [4]
 - 5. Compute fluently with complex numbers written in Cartesian form (HL) [5]
 - 6. Explain the relationships between different sets of numbers; i.e., the complex, real, rational, irrational numbers, and the integers (St) [7]
 - 7. Expand powers of binomials using the Binomial Theorem and apply the resulting binomial coefficients to general combinatorial problems (HL, SL) [10]
 - 8. Identify arithmetic, geometric, and other sequences, and compute finite and infinite sums (where possible) of such sequences (HL, SL, St) [10]
 - 9. Use summation notation to represent the sum of a sequence, and to illustrate the basic properties of this notation (HL, SL, St) [10]
 - 10. Perform operations with complex numbers expressed in Cartesian or polar form (HL) [6]

Standard II Algebra - Understand patterns, relations, and functions - Represent and analyze mathematical situations and structures using algebraic symbols - Use mathematical models

to represent and understand quantitative relationships - Analyze change in various contexts

- 1. Define a "function" and to use and understand the $f(x)$ notation (HL, SL, St) [16]
- 2. Describe and compare fundamental characteristics of the following functions: square root, cubic, absolute value, and basic trigonometric functions (e.g., general shapes and symmetries of the graphs, zeros, domain and range, inverses) (HL, SL, St) [11]
- 3. Describe and compare the fundamental characteristics of the following families of functions: quadratic, polynomial, exponential, and rational functions (e.g., general shapes and symmetries of the graphs, zeros, domain and range, and asymptotic behavior) (St) [5]
- 4. Describe and compare the fundamental characteristics of the following families of functions: quadratic, polynomial, exponential, logarithmic, and rational functions (e.g., general shapes and symmetries of the graphs, zeros, domain and range, asymptotic behavior, inverses) (HL, SL) [12]
- 5. Use technology to graph and investigate a variety of functions (HL, SL, St) [26]
- 6. Perform

operations with compositions of functions (HL, SL)

[14]

- 7. Analyze transformations of functions (polynomial, rational, radical, exponential, logarithmic, and trigonometric) and the impact of these transformations on their graphs (HL, SL, St)
[16]
- 8. Identify amplitude, period (HL, SL, St), and phase shifts (HL, SL) in trigonometric functions and the impact on their graphs
[6]
- 9. Translate freely among tabular, graphical, and symbolic representations of functions
[20]
- 10. Represent the inverse of a function using tabular, graphical, and, (for certain families of functions), symbolic representations (HL, SL)
[17]
- 11. Find the maximum or minimum value of a quadratic function (HL, SL, St)
[7]
- 12. Use the discriminant to investigate the nature of the roots of a quadratic equation (HL, SL)
[4]
- 13. Illustrate and apply the properties of exponential functions (St)
[4]
- 14. Illustrate and apply the properties of exponential and logarithmic functions, including the inverse relationship between the two (HL, SL)
[6]

- 15. Solve exponential and logarithmic equations (HL, SL, St)
[8]
- 16. Solve real-world problems that can be modeled by linear, quadratic, square root, trigonometric, or exponential functions, including problems involving exponential growth/decay (HL, SL, St)
[16]
- 17. Apply division of polynomials (long division and synthetic division) to determine factors and remainders (HL)
[3]
- 18. Apply the Rational Zeros Theorem to finding zeros of polynomials with integer coefficients (HL)
[3]
- 19. Understand and apply the conjugate relationship among zeros of polynomials with real coefficients (HL)
[4]
- 20. Derive and apply the basic trigonometric identities, including the Pythagorean and double-angle identities (HL, SL)
[3]
- 21. Derive and apply the basic trigonometric identities, the Pythagorean, sum and difference, double and half-angle identities (HL)
[2]
- 22. Solve trigonometric equations (HL, SL, St)
[6]
- 23. Understand the definitions and applications of inverse trig functions (HL)
[2]
- 24. Solve systems of linear

equations with a variety of matrix techniques (Cramer's Rule, matrix inverse, and row reduction), using technology for more complex systems (HL, SL, St)

[6]

- 25. Distinguish among types of solutions for systems of linear equations: unique solutions, no solutions, or infinitely many solutions (HL)
[6]
- 26. Use vector addition, scalar multiplication, and dot product of vectors to solve problems (HL, SL)
[4]
- 27. Represent lines and planes in 3-D space using vector and Cartesian equations (HL)
[3]

Standard III Geometry
- Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems - Apply transformations and use symmetry to analyze mathematical situations - Use visualization, spatial reasoning, and geometric modeling to solve problems

- 1. Use trigonometric relationships to determine lengths and angle measures (e.g., using the Laws of Sines and Cosines to solve triangles) (HL, SL, St)
[8]
- 2. Solve triangles using the Ambiguous Case (SSA) (HL, SL)
[4]
- 3. Determine the angle between

two vectors/lines,
including
perpendicular
vectors (HL, SL)
[2]

- 4. Represent the solution of a system of linear equations as the intersection of lines (in 2-space and 3-space) and planes (in 3-space) (HL, SL)
[3]
- 5. Apply integration to calculate the area under a curve or the area between two curves (HL, SL)
[6]
- 6. Apply integration to calculate volumes of revolution (HL, SL)
[5]
- 7. Understand the geometry of complex numbers, especially as related to the modulus of a complex number (HL)
[3]

**Standard IV
Measurement -
Understand measurable
attributes of objects
and the units, systems,
and processes of
measurement - Apply
appropriate techniques,
tools, and formulas to
determine
measurements**

- 1. Translate freely between radian and degree measure and distinguish between their appropriate uses (HL, SL)
[4]
- 2. Calculate the length of an arc or the area of a sector or segment (HL, SL)
[4]
- 3. Calculate and interpret the magnitude of a vector in two- and three-dimensional space (HL, SL)
[4]

**Standard V Data
Analysis and
Probability - Formulate
questions that can be
addressed with data
and collect, organize,**

**and display relevant data to answer them -
 Select and use appropriate statistical methods to analyze data - Develop and evaluate inferences and predictions that are based on data -
 Understand and apply basic concepts of probability - Analyze the mathematics of change using differential calculus -
 Analyze the mathematics of accumulation using integral calculus**

- 1. Distinguish between the concepts of population, sample, random sample and frequency distribution of discrete and continuous data (HL, SL, St) [10]
- 2. Organize and compare data (grouped and ungrouped) using frequency tables and diagrams, stem-and-leaf, and box-and-whisker plots (HL, SL, St) [10]
- 3. Find the least-squares regression line and the correlation coefficient for bivariate data with a linear trend and interpret each of these statistics in the context of the given problem (St) [3]
- 4. Make predictions using regression lines (St) [5]
- 5. Use the Chi-square Test to determine independence (St) [5]
- 6. Use technology to compute measures of central tendency (mean, median, and mode) and measures of spread (range, interquartile range, quartiles, percentiles, variance and standard

deviation) and interpret in the context of the problem (HL, SL, St)

[10]

- 7. Use the standard normal curve to investigate properties of normal distributions (HL, SL)
[5]
- 8. Solve problems involving discrete random variables and their probability distributions (HL, SL)
[5]
- 9. Solve problems involving expectation and variance of discrete random variables (HL, SL)
[5]
- 10. Solve problems involving continuous random variables and their probability distributions (HL)
[3]
- 11. Solve problems involving expectation and variance of continuous random variables (HL)
[3]
- 12. Solve problems involving the Binomial Distribution (HL, SL)
[6]
- 13. Solve problems involving the Poisson Distribution (HL)
[3]
- 14. Use theoretical or experimental probability, including simulations, to determine probabilities in real-world problem situations (HL, SL, St)
[8]
- 15. Understand and be able to apply the concepts of mutually exclusive, complementary,

and independent events to probabilistic or statistical problems (HL, SL, St)

[8]

- 16. Understand and be able to apply the concept of conditional probability (HL, SL, St)
[9]
- 17. Use Venn diagrams, tree diagrams, and tables to illustrate probability outcomes (HL, SL, St)
[8]

Standard A Analysis
– Analyze the mathematics of change using differential calculus
– Analyze the mathematics of accumulation using integral calculus

- 1. Analyze the asymptotic behavior of functions using the concept of limit (HL, SL)
[10]
- 2. Define and interpret (slope of tangent line) the derivative of a function using limits (HL, SL)
[8]
- 3. Develop and apply rules of differentiation for common algebraic and transcendental functions (HL, SL)
[8]
- 4. Differentiate more complex functions using the Product, Quotient, and Chain Rules for the derivative (HL, SL)
[8]
- 5. Apply implicit differentiation to compute derivatives of implicitly defined functions (HL)
[5]
- 6. Interpret and apply the derivative to solve problems involving rates of change (HL, SL)
[8]
- 7. Interpret and apply the

- derivative to solve optimization problems (HL, SL)
[5]
- 8. Analyze higher rates of change (e.g., acceleration) and the geometry of concavity using the second derivative (HL, SL)
[5]
 - 9. Use the first and second derivatives to analyze the local and global behavior of functions (HL, SL)
[7]
 - 10. Understand and apply the antiderivative (indefinite integral) as the inverse of the derivative. (HL, SL)
[7]
 - 11. Understand, interpret, and apply the concept of a definite integral in the context of the Fundamental Theorem of Calculus (HL, SL)
[7]
 - 12. Compute antiderivatives of basic algebraic and transcendental functions (HL, SL)
[8]
 - 13. Develop and apply techniques of integration, u-substitution (HL, SL), trig substitutions, integration by parts, and integration by partial fractions (HL)
[8]
 - 14. Apply differential and integral calculus to problems of kinematics (HL, SL)
[9]
 - 15. Solve separable first-order differential equations by separation of variables (HL)
[4]

Standard VI Problem Solving - Build new mathematical knowledge through

problem solving - Solve problems that arise in mathematics and in other contexts - Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving

- 1. Use a variety of problem-solving strategies relevant to the level of mathematics of the course and reflect on this process
[25]

Standard VII Reasoning and Proof - Recognize reasoning and proof as fundamental aspects of mathematics - Make and investigate mathematical conjectures - Develop and evaluate mathematical arguments and proofs - Select and use various types of reasoning and methods of proof

- 1. Recognize, understand, and develop the concept of mathematical proof as a fundamental aspect of mathematics at a level appropriate to the course
[20]
- 2. Prove statements using the principle of mathematical induction (HL)
[5]
- 3. Understand the concept of a set, and to use appropriate notation (St)
[2]
- 4. Translate between verbal and symbolic statements (St)
[2]
- 5. Introduce principles of logic and to analyze verbal and symbolic statements (St)
[2]

Standard VIII Communication - Organize and consolidate their mathematical thinking through communication - Communicate their

mathematical thinking coherently and clearly to peers, teachers and others - Analyze and evaluate the mathematical thinking and strategies of others - Use the language of mathematics to express mathematical ideas precisely

- 1. Organize, consolidate, analyze, and evaluate their mathematical thinking at a level appropriate to the level of the course
[38]
- 2. Translate mathematical expressions into precise language for technology relevant to the level of the course
[36]
- 3. Translate verbal expressions into precise mathematical language to the level of the course
[40]

**Standard IX
Connections - Recognize and use connections among mathematical ideas - Understand how mathematical ideas interconnect and build on one another to produce a coherent whole - Recognize and apply mathematics in contexts outside of mathematics**

- 1. Recognize and use connections among mathematical ideas appropriate to the mathematical level of the course
[44]
- 2. Understand the concepts underlying certain financial transactions (St)
[1]
- 3. Use iterative processes or successive approximations that are valid to obtain a solution to a problem involving simple and compound interest (St)

[1]

**Standard X
Representation - Create and use representations to organize, record, and communicate mathematical ideas - Select, apply, and translate among mathematical representations to solve problems - Use representations to model and interpret physical, social, and mathematical phenomena**

- 1. Create, use, select, apply, and translate mathematical representations appropriate to the level of the course

[45]

Algebra 1

Standard I Number and Operations

-Understand numbers, ways of representing numbers, relationships among numbers and number systems
-Understand meanings of operations and how they relate to one another
-Compute fluently and make reasonable estimates

- 1. Compare, order, and determine equivalent forms for rational and irrational numbers
- 2. Perform arithmetic operations on numbers written in scientific notation
- 3. Perform operations on and simplify expressions involving radicals (including estimating square roots and simplifying $3/\sqrt{2}$)

Standard II Algebra

□ Understand patterns, relations, and functions
-Represent and analyze mathematical situations and structures using algebraic symbols
-Use mathematical models to represent and understand

**quantitative
relationships
-Analyze change in
various contexts**

- 1. Find the domain and range of relations and functions
- 2. Recognize, represent and analyze patterns of linear, quadratic, absolute value, radical and exponential functions through tables, graphs and algebraic representations
- 3. Model and solve real-life situations using linear (equations and inequalities), quadratic and exponential models through tables, graphs and algebraic representations
- 4. Identify the relationship between zeros of a function and roots of equations, both graphically and in words
- 5. Write and use equivalent forms of equations (such as writing linear equations in slope-intercept form), and inequalities
- 6. Recognize and explain that the slopes of parallel lines are equal and the slopes of perpendicular lines are negative reciprocals
- 7. Solve systems of linear equations and inequalities using graphs, substitution, and elimination
- 8. Solve quadratic equations with real roots by factoring, graphing, and using the quadratic formula
- 9. Perform operations on algebraic expressions involving monomials and polynomials

- 10. Transpose equations for a specified variable given more than one variable
- 11. Simplify and perform operations on rational expressions, and solve rational equations
- 12. Simplify expressions and solve equations involving square roots
- 13. Calculate exponential growth and decay (e.g., compound interest)
- 14. Evaluate functions graphically, numerically and algebraically
- 15. Describe how a change in the value of a constant in linear and quadratic equations affects the related graphs and table of values
- 16. Solve multi-step linear equations and inequalities (including compound) using a variety of methods

Standard III Geometry

-Analyze

characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships

-Specify locations and describe spatial relationships using coordinate geometry and other representational systems

-Apply transformations and use symmetry to analyze mathematical situations

-Use visualization, spatial reasoning, and geometric modeling to solve problems

- 1. Model and solve real-world problems using the Pythagorean theorem
- 2. Demonstrate and apply the relationship between the

Pythagorean theorem and the distance formula

- 3. Use graphical and algebraic methods to solve problems involving distance, midpoint, and slope
- 4. Transform basic functions (e.g., parabolas, absolute value) on a coordinate plane

**Standard IV
Measurement**
-Understand measurable attributes of objects and the units, systems, and processes of measurement
-Apply appropriate techniques, tools, and formulas to determine measurements

- 1. Describe relationships among units (metric and customary) and convert from one unit to another within the same system
- 2. Solve simple problems involving rates and derived measurements for such attributes as velocity and density
- 3. Check solutions to problems for reasonable results in context

Standard V Data Analysis
-Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
-Select and use appropriate statistical methods to analyze data
-Develop and evaluate inferences and predictions that are based on data
-Understand and apply basic concepts of probability

- 1. Select, create, and use appropriate graphical representations of data using

- scatter plots
- 2. Discuss and understand the correspondence between data sets and their graphical representations especially scatter plots
- 3. Make conjectures about possible relationships between two characteristics of a sample on the basis of scatter plots of the data and approximate lines of fit
- 4. Judge whether a sample is representative, depending on a number of factors (e.g., amount of data collected, what is known about the situation, how current data are)

Standard VI Problem Solving

-Build new

mathematical knowledge through problem solving

-Solve problems that arise in mathematics and in other contexts

-Apply and adapt a variety of appropriate strategies to solve problems

-Monitor and reflect on the process of mathematical problem solving

- 1. Build new mathematical knowledge through regular problem solving, including content and supplementary activities
- 2. Solve problems that arise in mathematics and in other contexts
- 3. Develop and apply strategies to a wide variety of problems, i.e. applying logical reasoning, use of manipulatives, identifying patterns, guess, check, and revise, work backwards, draw picture, table, diagram
- 4. Monitor and reflect on the

process of
problem solving
(i.e., identifying
extraneous
information,
estimating
solutions for
problems,
determining the
reasonableness
of a solution by
comparing it to
an estimate,
choosing an
appropriate
calculation
method)

- 5. Formulate problems from everyday and mathematical situations

Standard VII

Reasoning and Proof

-Recognize reasoning and proof as fundamental aspects of mathematics

-Make and investigate mathematical conjectures

-Develop and evaluate mathematical arguments and proofs

-Select and use various types of reasoning and methods of proof

- 1. Make and investigate mathematical conjectures of explore these conjectures
- 2. Recognize, understand and develop the concept of a mathematical proof as fundamental aspects of mathematics
- 3. Select and use various types of reasoning and methods of proof

Standard VIII

Communication

-Organize and consolidate their mathematical thinking through communication

-Communicate their mathematical thinking coherently and clearly to peers, teachers and others

-Analyze and evaluate the mathematical thinking and strategies of others

-Use the language of mathematics to express mathematical ideas precisely

- 1. Organize and

- consolidate their mathematical thinking through communication
- 2. Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
- 3. Analyze and evaluate the mathematical thinking and strategies of others
- 4. Use the language of mathematics to express the mathematical ideas precisely
- 5. Translate mathematical expressions into precise language for technology

Standard IX Connections

-Recognize and use connections among mathematical ideas
-Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
-Recognize and apply mathematics in contexts outside of mathematics

- 1. Recognize and use connections among mathematical ideas
- 2. Understand connections between equivalent representations and corresponding procedures of the same problem situation or mathematical concept
- 3. Recognize and apply mathematics in contexts outside of mathematics
- 4. Recognize that mathematics provides a precise system to describe objects, events, and relationships enabling the construction of logical arguments
- 5. Understand

how the continued advancements of technology open new doors to the discovery of new mathematics and the development of current mathematics

**Standard X
Representation**
-Create and use representations to organize, record, and communicate mathematical ideas
-Select, apply, and translate among mathematical representations to solve problems
-Use representations to model and interpret physical, social, and mathematical phenomena

- 1. The learner will be able to create and use representation (manipulatives, computers, graphing calculators, pencil and paper) to organize, record, and communicate mathematical ideas
- 2. Select, apply, and translate among mathematical representations to solve problems
- 3. Use representations to model and interpret physical, social, and mathematical phenomena

Algebra Part 1

Standard I Number and Operations
-Understand numbers, ways of representing numbers, relationships among numbers and number systems
-Understand meanings of operations and how they relate to one another
-Compute fluently and make reasonable estimates

- 1. Compare, order, and determine equivalent forms for rational numbers.

Standard II Algebra
-Understand patterns, relations, and functions
-Represent and analyze mathematical situations and structures using algebraic symbols
-Use mathematical models to represent and understand quantitative relationships
-Analyze change in various contexts

- 1. Find the domain and range of relations and functions
- 2. Recognize, represent and analyze patterns of linear, quadratic and, absolute value functions, through tables, graphs and algebraic representations
- 3. Model and solve real-life situations using linear models (equations and inequalities), through tables, graphs and algebraic representations
- 4. Write and use equivalent forms of equations (such as writing linear equations in slope-intercept form), and inequalities
- 5. Recognize and explain that the slopes of parallel lines are equal and the slopes of perpendicular lines are negative reciprocals
- 6. Transpose equations for a specified variable given more than one variable
- 7. Evaluate functions graphically, numerically and algebraically
- 8. Describe how a change in the value of a constant in linear and quadratic equations affects the related graphs and table of values
- 9. Solve multi-

step linear
equations and
inequalities
(including
compound)
using a variety
of methods

Standard III Geometry

**-Analyze
characteristics and
properties of two and
three dimensional
geometric shapes and
develop mathematical
arguments about
geometric
relationships**

**-Specify locations and
describe spatial
relationships using
coordinate geometry
and other
representational
systems**

**-Apply transformations
and use symmetry to
analyze mathematical
situations**

**-Use visualization,
spatial reasoning, and
geometric modeling to
solve problems**

- 1. Transform
basic functions
(e.g., parabolas,
absolute value)
on a coordinate
plane

**Standard IV
Measurement**

**-Understand
measurable attributes
of objects and the
units, systems, and
processes of
measurement**

**-Apply appropriate
techniques, tools, and
formulas to determine
measurements**

- 1. Describe
relationships
among units
(metric and
customary) and
convert from one
unit to another
within the same
system
- 2. Solve simple
problems
involving rates
and derived
measurements
for such
attributes as
velocity and
density
- 3. Check
solutions to
problems for
reasonable
results in
context

**Standard V Data
Analysis**

-Formulate questions

that can be addressed with data and collect, organize, and display relevant data to answer them

-Select and use appropriate statistical methods to analyze data

-Develop and evaluate inferences and predictions that are based on data

-Understand and apply basic concepts of probability

- 1. Select, create, and use appropriate graphical representations of data using scatter plots
- 2. Discuss and understand the correspondence between data sets and their graphical representations especially scatter plots
- 3. Make conjectures about possible relationships between two characteristics of a sample on the basis of scatter plots of the data and approximate lines of fit

Standard VI Problem Solving

-Build new mathematical knowledge through problem solving

-Solve problems that arise in mathematics and in other contexts

-Apply and adapt a variety of appropriate strategies to solve problems

-Monitor and reflect on the process of mathematical problem solving

- 1. Build new mathematical knowledge through regular problem solving, including content and supplementary activities
- 2. Solve problems that arise in mathematics and in other contexts
- 3. Develop and apply strategies to a wide variety of problems, i.e. applying logical

reasoning, use of manipulatives, identifying patterns, guess, check, and revise, work backwards, draw picture, table, diagram

- 4. Monitor and reflect on the process of problem solving (i.e., identifying extraneous information, estimating solutions for problems, determining the reasonableness of a solution by comparing it to an estimate, choosing an appropriate calculation method)
- 5. Formulate problems from everyday and mathematical situations

Standard VII
Reasoning and Proof
-Recognize reasoning and proof as fundamental aspects of mathematics
☐ **Make and investigate mathematical conjectures**
-Develop and evaluate mathematical arguments and proofs
-Select and use various types of reasoning and methods of proof

- 1. Make and investigate mathematical conjectures and explore these conjectures
- 2. Recognize, understand and develop the concept of a mathematical proof as fundamental aspects of mathematics
- 3. Select and use various types of reasoning and methods of proof

Standard VIII
Communication
-Organize and consolidate their mathematical thinking through communication
-Communicate their mathematical thinking coherently and clearly

to peers, teachers and others

-Analyze and evaluate the mathematical thinking and strategies of others

-Use the language of mathematics to express mathematical ideas precisely

- 1. Organize and consolidate their mathematical thinking through communication
- 2. Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
- 3. Analyze and evaluate the mathematical thinking and strategies of others
- 4. Use the language of mathematics to express the mathematical ideas precisely
- 5. Translate mathematical expressions into precise language for technology

Standard IX Connections

-Recognize and use connections among mathematical ideas

-Understand how mathematical ideas interconnect and build on one another to produce a coherent whole

-Recognize and apply mathematics in contexts outside of mathematics

- 1. Recognize and use connections among mathematical ideas
- 2. Understand connections between equivalent representations and corresponding procedures of the same problem situation or mathematical concept
- 3. Recognize and apply mathematics in contexts outside of mathematics
- 4. Recognize

that
 mathematics
 provides a
 precise system
 to describe
 objects, events,
 and relationships
 enabling the
 construction of
 logical
 arguments

- 5. Understand
 how the
 continued
 advancements of
 technology open
 new doors to the
 discovery of new
 mathematics and
 the development
 of current
 mathematics

Standard X

Representation

**-Create and use
 representations to
 organize, record, and
 communicate
 mathematical ideas**

**-Select, apply, and
 translate among
 mathematical
 representations to
 solve problems**

**-Use representations
 to model and interpret
 physical, social, and
 mathematical
 phenomena**

- 1. The learner
 will be able to
 create and use
 representation
 (manipulatives,
 computers,
 graphing
 calculators,
 pencil and
 paper) to
 organize, record,
 and
 communicate
 mathematical
 ideas
- 2. Select, apply,
 and translate
 among
 mathematical
 representations
 to solve
 problems
- 3. Use
 representations
 to model and
 interpret
 physical, social,
 and
 mathematical
 phenomena

Geometry

Standard I Number

and Operations -

**Understand numbers,
 ways of representing
 numbers, relationships
 among numbers and
 number systems -
 Understand meanings**

of operations and how they relate to one another - Compute fluently and make reasonable estimates

- 1. Make connections between verbal and symbolic representations of irrational numbers (i.e., the hypotenuse and the Pythagorean Theorem)
- 2. Compute fluently and make reasonable estimates, for instance for areas and volumes
- 3. Perform operations on and simplify expressions involving radicals
- 4. Compute with rational and irrational numbers expressed in a variety of forms. Explain the meaning of n th root, and estimate the n th root of a given positive integer by locating it between consecutive integers (e.g., the 4th root of 50 is between 2 and 3)

Standard II Algebra - Understand patterns, relations, and functions - Represent and analyze mathematical situations and structures using algebraic symbols - Use mathematical models to represent and understand quantitative relationships - Analyze change in various contexts

- 1. Analyze patterns and sequences, especially those that pertain to geometric patterns
- 2. Model and solve real-life situations using linear (equations and inequalities), quadratic and exponential models through tables, graphs

- and algebraic representations
- 3. Write and use equivalent forms of equations (such as writing linear equations in slope-intercept form.)
- 4. Recognize and explain that the slopes of parallel lines are equal and the slopes of perpendicular lines are negative reciprocals
- 5. Solve systems of linear equations and inequalities using graphs, substitution, and elimination
- 6. Perform operations on algebraic expressions involving monomials and polynomials
- 7. Transpose equations for a specified variable given more than one variable
- 8. Simplify and perform operations on rational expressions, and solve rational equations
- 9. Solve multi-step linear equations using a variety of methods.
- 10. Solve real-world problems that can be modeled using systems of linear equations

Standard III Geometry
- Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical arguments about geometric relationships - Specify locations and describe spatial relationships using coordinate geometry and other representational systems - Apply transformations and use symmetry to analyze mathematical situations - Use visualization, spatial reasoning, and geometric modeling to solve problems

- 1. Define and

- explain key aspects of geometric figures, including: a) Interior and exterior angles of polygons b) Segments related to triangles (median, altitude, mid-segment) c) Points of concurrency related to triangles (centroid, incenter, orthocenter, circumcenter) d) Circles (radius, diameter, chord, circumference, major arc, minor arc, sector, segment, inscribed angle)
- 2. Identify the angles formed and apply the relationships between the angles formed either by two intersecting lines or by parallel lines cut by a transversal
- 3. Use proportions to solve problems involving similar figures
- 4. Define and apply the basic trigonometric ratios in right triangles: sine, cosine, and tangent
- 5. Apply proportions and right triangle trigonometric ratios to solve problems involving missing lengths and angle measures in similar figures
- 6. Explain the necessity for certain terms to remain undefined, such as point, line and plane
- 7. Represent and analyze shapes using coordinate geometry (e.g., given three vertices and the type of quadrilateral, find the coordinates of the fourth vertex; or use

- distance and/or slope to show that a quadrilateral is a parallelogram)
- 8. Construct right triangles, equilateral triangles, parallelograms, trapezoids, rectangles, rhombuses, squares and kites, using compass and straightedge or dynamic geometry software
- 9. Construct congruent figures using tools, such as compass, straightedge, and protractor or dynamic geometry software
- 10. Perform translations, reflections, rotations, and dilations of twodimensional figures using a variety of methods (e.g., paper folding, tracing, coordinate geometry, with construction)
- 11. Identify the properties of a geometric figure that remain fixed under various transformations (e.g., lengths of sides remain the same under translations)
- 12. Describe and display the results of combinations of translations, reflections and rotations (compositions), (e.g., perform compositions and specify the result of a composition as the outcome of a single motion, when applicable)
- 13. Represent three-dimensional geometric objects two-dimensionally (e.g., using nets, orthogonal drawing or isometric drawing)

- 14. Solve problems involving chords, radii, tangents and arcs of a circle
- 15. Model and solve real-world problems using the Pythagorean theorem
- 16. Demonstrate and apply the relationship between the Pythagorean theorem and the distance formula
- 17. Use graphical and algebraic methods to solve problems involving distance, midpoint, and slope
- 18. Transform basic functions on a coordinate plane.
- 19. Use trigonometric relationships to determine lengths and angle measures (e.g., using the Laws of Sines and Cosines to solve triangles)

**Standard IV
Measurement -
Understand
measurable attributes
of objects and the
units, systems, and
processes of
measurement - Apply
appropriate
techniques, tools, and
formulas to determine
measurements**

- 1. Convert from one unit to another both between and within systems
- 2. Explain and apply strategies to find the area of composite shapes using area of triangles, parallelograms, circles and sectors
- 3. Explain the difference between surface area and volume and demonstrate that two objects may have the same surface area, but two different volumes, or may have the same volume, but

- different surface areas
- 4. Analyze changes to related measures when one or more dimensions of a geometric figure are changed (e.g., length of sides are doubled)
- 5. Derive formulas for surface area and volume and justify them using geometric models and common materials. For example, find:
 - a) The surface area of a cylinder as a function of its height and radius
 - b) That the volume of a pyramid (or cone) is one-third of the volume of a prism (or cylinder) with the same base area and height
- 6. Solve problems involving the interior and exterior angles of convex polygons
- 7. Use conventional formulas to find the surface area and volume of prisms, pyramids, cylinders, and spheres and the volume of cones to a specified level of precision including the surface area of a cone as a function of its slant height and the circumference of its base
- 8. Demonstrate understanding of the concepts of perimeter, circumference and area by using established formulae for triangles, quadrilaterals, circles and polygons
- 9. Use the ratio of lengths in similar two-dimensional figures or

three-dimensional objects to calculate the ratio of their areas or volumes respectively

- 10. Use scale drawings and right triangle trigonometry to solve problems that include unknown distances and angle measures
- 11. Determine the measures of central and inscribed angles and their associated major and minor arcs
- 12. Calculate lengths, areas, surface areas, and volumes of composite three-dimensional objects to a specified level of precision
- 13. Solve real-world problems involving area, surface area, volume and density to a specified level of precision
- 14. Describe relationships among units and convert from one unit to another within the same system
- 15. Solve simple problems involving rates and derived measurements for such attributes as velocity and density
- 16. Check solutions to problems for reasonable results in context
- 17. Determine the number of significant digits in a measurement and to round a given
- 18. Translate freely between radian and degree measure and distinguish between their appropriate uses (TP)

Standard V Data Analysis and Probability – Formulate questions that can be addressed

with data and collect, organize, and display relevant data to answer them – Select and use appropriate statistical methods to analyze data – Develop and evaluate inferences and predictions that are based on data – Understand and apply basic concepts of probability

- 1. Use technology to compute measures of central tendency (mean, median, and mode) and measures of spread (range, quartiles, and standard deviation) and interpret in the context of the problem (TP)

Standard VI Problem Solving - Build new mathematical knowledge through problem solving - Solve problems that arise in mathematics and in other contexts - Apply and adapt a variety of appropriate strategies to solve problems - Monitor and reflect on the process of mathematical problem solving.

- 1. Use a variety of problem-solving strategies relevant to the level of mathematics of the course and reflect on this process

Standard VII Reasoning and Proof - Recognize reasoning and proof as fundamental aspects of mathematics - Make and investigate mathematical conjectures - Develop and evaluate mathematical arguments and proofs - Select and use various types of reasoning and methods of proof

- 1. Recognize, understand, and develop the concept of mathematical proof as a

fundamental aspect of mathematics at a level appropriate to the course

- 2. The learner will be able to select and use various types of reasoning and methods of proof
- 3. Make, test, and establish the validity of conjectures about geometric properties and relationships using counterexample, inductive and deductive reasoning, and paragraph or two-column proof and constructions (patty/tracing paper, compass, and Geometric sketchpad)

Standard VIII
Communication -
Organize and consolidate their mathematical thinking through communication -
Communicate their mathematical thinking coherently and clearly to peers, teachers and others -
Analyze and evaluate the mathematical thinking and strategies of others -
Use the language of mathematics to express mathematical ideas precisely

- 1. Organize, consolidate, analyze, and evaluate their mathematical thinking at a level appropriate to the level of the course
- 2. Translate mathematical expressions into precise language for technology relevant to the level of the course
- 3. Translate verbal expressions into precise mathematical language to the level of the course

Standard IX
Connections -

Recognize and use connections among mathematical ideas - Understand how mathematical ideas interconnect and build on one another to produce a coherent whole - Recognize and apply mathematics in contexts outside of mathematics

- 1. Recognize and use connections among mathematical ideas appropriate to the mathematical level of the course

**Standard X
Representation - Create and use representations to organize, record, and communicate mathematical ideas - Select, apply, and translate among mathematical representations to solve problems - Use representations to model and interpret physical, social, and mathematical phenomena**

- 1. Create, use, select, apply, and translate mathematical representations appropriate to the level of the course

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