

MATHEMATICS COURSE OF STUDY

K - 12

2004



Lucia D. McQuaide, Superintendent

William Weisner, Director of Curriculum and Instruction

Jeri Rod, Director of School Assessment

Office of Catholic Schools

Catholic Diocese of Columbus

TABLE OF CONTENTS

INTRODUCTION.....2

MATHEMATICS PHILOSOPHY.....2

PRINCIPLES FOR MATHEMATICS FOR THE DIOCESE OF COLUMBUS CATHOLIC SCHOOLS.....3

MATHEMATICS COURSE OF STUDY COMMITTEE.....4

CODE.....5

CONTENT STANDARDS.....6-11

OHIO K-12 MATHEMATICS STANDARDS.....12-22

ASSESSMENT.....23

INTRODUCTION

The following is the revised K-12 Mathematics Course of Study for the Catholic Diocese of Columbus. In the process of revising the K-12 Mathematics Course of Study, the committee used the Academic Content Standards for the State of Ohio and the *Principles and Standards for School Mathematics* as published by the National Council of Teachers of Mathematics.

MATHEMATICS PHILOSOPHY

The goal of mathematics is to produce mathematically literate individuals who can function in a world of increasing moral and technological complexity. To meet this challenging goal, the students in the Diocese of Columbus Catholic Schools will need to develop problem-solving skills as well as employ the knowledge of their Catholic faith. By growing in knowledge of problem solving and understanding of their Catholic beliefs, the students will be able to meet society's demands for well-informed citizens who can reason logically, think critically, solve problems creatively, resourcefully and morally, and communicate with others effectively. The need to understand and to be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase. Those who accomplish this goal will significantly enhance their opportunities for shaping their future and the future of others.

In keeping with this goal, students are presented with a sequential development of mathematical concepts. The Mathematics Course of Study for the Diocese and the Academic Content Standards for the State of Ohio are the foundation of all instruction, assessment and evaluation. The classroom environment fosters enthusiastic learning and appreciation for the power, beauty and usefulness of mathematics. Students will see mathematics as an interdisciplinary problem solving tool, as a critical skill for providing a variety of career options, as a universal language and as an art. These perspectives will enrich our students' experiences in school and provide a pathway through the twenty-first century.

Principles for Mathematics for the Diocese of Columbus Catholic Schools

Equity. Excellence in mathematics education requires equity--high expectations *based on the Diocesan Mathematics Course of Study and the Academic Content Standards for the State of Ohio* and strong support for all students.

Curriculum. A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, *integrated with our Catholic values* and well articulated across the grades.

Teaching. Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.

Learning. Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.

Assessment. Assessment should support the learning of important mathematics, *be varied*, and furnish useful information to teachers, students, *and parents*.

Technology. Technology is essential in teaching and learning mathematics *and should be integrated in teaching learning process*; technology influences the mathematics that is taught and enhances students' learning.

Based on *Principles and Standards for School Mathematics*, National Council of Teachers of Mathematics.

Mathematics Course of Study Committee

Molly Backlund	Blessed Sacrament School	Sue Krautter	St. Mary Magdalene School
Gwyn Barker	Notre Dame High School	Richard Logue	St. Timothy School
Vickie Brake	St. Agatha School	Jim Lower	St. Charles Preparatory School
Karen Brougher	St. Patrick School	Virginia O'Connor	Bishop Watterson High School
Barbara Camboni	St. Matthias School	Marcine Power	St. Paul School
Linda Cotter	St. Mary School	Tiffany Ray	Christ the King School
Terra Dilley	St. Vincent de Paul School	Carol Rearick	St. Catharine School
Shawnda Faccinto	Holy Spirit School	Greg Reed	Our Lady of Perpetual Help School
Anita Foraker	Bishop Hartley High School	Terri Rehner	Bishop Ready High School
Diane Gates	St. Timothy School	Jeri Rod	Department of Education
David Gebhart	St. Francis DeSales School	John Salyer	St. Charles Preparatory School
Karen Harwell	St. Brendan School	Sharon Stranges	St. Catharine School
JoAnne Hay	St. Pius X School	Marilyn Turnock	Immaculate Conception School
John Hohman	Bishop Rosecrans High School	Sheryl Valentine	St. Mary School, Delaware
Carolyn Hughes	St. Cecilia School	Bill Weisner	Department of Education
Marylu Jardine	Newark Catholic High School	Angie Windau	St. Francis DeSales High School

Code

The Skills in the Scope and Sequence have been coded as follows:

I – indicates “INTRODUCE” the skill or concept at this grade level.

D – indicates “DEVELOP” the skill by reviewing, extending, and treating it in greater depth than the previous year(s).

M – indicates “MASTER” the skills by being able to perform the skill or demonstrate an understanding of the concept at an acceptable level.

m – indicates “MAINTAIN” the skill by being able to perform the skill or demonstrate it in higher level math courses.

*****- indicates in which high school course the concept is to be taught.

Content Standard I: Mathematical Processes

Students use mathematical processes and knowledge to solve problems. Students apply problem-solving and decision-making techniques, and communicate mathematical ideas.

The student will:

	K	1	2	3	4	5	6	7	8	9	10	11	12
A. Use a variety of tools and strategies in problem solving.	I	I/D	D	D	D	D	D	D	D	D	M	m	m
B. Apply mathematical knowledge and skills routinely in other content areas and practical situations.	I	I/D	D	D	D	D	D	D	D	D	M	m	m
C. Recognize and use connections between equivalent representations and related procedures.	I	D	D	D	D	D	D	D	D	D	M	m	m
D. Evaluate the reasonableness of predictions, estimations, and solutions.		I	D	D	D	D	D	D	D	D	M	m	m
E. Use a variety of mathematical representations to organize, record, and communicate mathematical ideas.	I	D	D	D	D	D	D	D	D	D	M	m	m
F. Use mathematical language and symbols to explain, analyze, and justify mathematical ideas, strategies, and solutions.	I	I/D	D	D	D	D	D	D	D	D	M	m	m
G. Write clearly and coherently about mathematical thinking and ideas.		I	D	D	D	D	D	D	M	m	m	m	m

Content Standard II: Number, Number Sense and Operations

Students demonstrate number sense, including an understanding of number systems and operations and how they relate to one another.

Students compute fluently and make reasonable estimates using paper and pencil, technology-supported and mental methods.

The student will:

	K	1	2	3	4	5	6	7	8	9	10	11	12
A. Use physical, verbal and symbolic representations to relate mathematical concepts.	I	D	D	D	D	D	D	D	M	M	M	m	m
B. Use, analyze and apply operations and properties of numbers.	I	D	D	D	D	D	D	D	M	M	M	m	m
C. Compare, order and determine equivalent forms of real numbers.	I	D	D	D	D	D	D	D	D	M	M	m	m
D. Use a variety of methods, tools and strategies (mental math, estimation, manipulatives).	I	D	D	D	D	D	D	D	D	M	M	m	m
E. Compute and estimate fluently.		I	I/D	D	D	D	D	D	M	m	m	m	m

Content Standard III: Measurement

Students estimate and measure to a required degree of accuracy and precision by selecting and using appropriate units, tools and technologies.

The student will:

	K	1	2	3	4	5	6	7	8	9	10	11	12
A. Explain the need for standard units of measure.	I	D	D	M	m	m	m	m	m	m	m	m	m
B. Select appropriate units for using metric and customary units.	I	D	D	D	D	D	D	M	m	m	m	m	m
C. Apply direct and indirect measurement techniques, estimations, tools and formulas.	I	D	D	D	D	D	D	D	D	D	M	m	m
D. Develop common referents to make comparison and estimations.	I	D	D	D	D	D	D	M	m	m	m	m	m
E. Convert and order within the same measurement system.			I	I/D	D	D	D	D	M	m	m	m	m

Content Standard IV: Geometry and Spatial Sense

Students identify, classify, compare and analyze characteristics, properties and relationships of one-,two- and three-dimensional geometric figures and objects. Students use spatial reasoning, properties of geometric objects, and transformations to analyze mathematical situations and solve problems.

The student will:

	K	1	2	3	4	5	6	7	8	9	10	11	12
A. Identify, sort and compare characteristics and properties of two- & three- dimensional objects.	I	I/D	D	D	D	D	D	D	D	D	M	m	m
B. Use a coordinate system.	I	I/D	D	D	D	D	D	D	D	D	M	m	m
C. Describe and define properties of lines.				I	D	D	D	D	D	D	M	m	m
D. Describe and define properties of angles.				I	D	D	D	D	D	D	M	m	m
E. Draw and construct two- and three- dimensional objects.	I	I/D	D	D	D	D	D	D	D	D	M	m	m
F. Transform lines and shapes.			I	D	D	D	D	D	D	D	M	m	m
G. Define and identify geometric terms.	I	I/D	D	D	D	D	D	D	D	D	M	m	m
H. Determine and explain validity of geometric relationships.									I	D	M	m	m
I. Apply geometric principles to problems.	I	D	D	D	D	D	D	D	D	D	M	m	m

Content Standard V: Patterns, Functions and Algebra

Students use patterns, relations and functions to model, represent and analyze problem situations that involve variable quantities. Students analyze, model and solve problems using various representations such as tables, graphs and equations.

The student will:

	K	1	2	3	4	5	6	7	8	9	10	11	12
A. Sort, classify and order objects and describe the attributes used.	I	I/D	D	D	D	D	D	D	D	M	m	m	m
B. Describe, analyze and extend patterns and sequences.	I	I/D	I/D	D	D	D	D	D	D	M	m	m	m
C. Generate and explain patterns and sequences.	I	I/D	I/D	D	D	D	D	D	D	M	m	m	m
D. Represent, analyze and generate a variety of patterns and functions with tables, graphs, words and symbolic rules.	I	I/D	D	D	D	D	D	D	D	M	m	m	m
E. Translate information from one representation (words, tables, graphs, or equations) to another.	I	I/D	I	D	D	D	D	D	D	M	m	m	m
F. Apply various methods to represent and generalize problem situations.	I	I/D	I/D	D	D	D	D	D	D	M	m	m	m
G. Use rules and variables to describe patterns, functions and other relationships.			I	D	D	D	D	D	D	M	m	m	m
H. Use representations, such as tables, graphs and equations to model situations and to solve problems.	I	D	D	D	D	D	D	D	D	M	m	m	m
I. Write, simplify and evaluate algebraic expressions.		I/D	D	D	D	D	D	D	M	m	m	m	m
J. Solve equations and inequalities symbolically, graphically and numerically.		I/D	D	D	D	D	D	D	D	M	m	m	m
K. Describe how a change in one variable affects the value of a related variable.				I	D	D	D	D	D	M	m	m	m
L. Use formulas in problem-solving situations.				I	D	D	D	D	D	M	m	m	m

Content Standard VI: Data Analysis and Probability

Students pose questions and collect, organize, represent, interpret and analyze data to answer those questions. Students develop and evaluate inferences, predictions and arguments that are based on data.

The student will:

	K	1	2	3	4	5	6	7	8	9	10	11	12
A. Identify, gather and sort data.	I	D	D	D	D	D	D	D	M	m	m	m	m
B. Construct and display data.	I	D	D	D	D	D	D	D	M	m	m	m	m
C. Analyze data.	I	D	D	D	D	D	D	D	M	m	m	m	m
D. Draw conclusions based on data.	I	I/D	D	D	D	D	D	D	M	m	m	m	m
E. Describe and evaluate sampling methods.			I	D	D	D	D	D	D	D	M	m	m
F. List and predict possible outcomes using data.	I	I/D	D	D	D	D	D	D	D	M	m	m	m
G. Design and perform statistical experiments.				I	D	D	D	D	D	M	m	m	m
H. Understand and apply basic probability.		I	I/D	D	D	D	D	D	D	M	m	m	m
I. Evaluate the validity of statistics.						I	D	D	D	M	m	m	m

OHIO'S K-12 MATHEMATICS STANDARDS

I. Mathematical Processes Standard

Students use mathematical processes and knowledge to solve problems. Students apply problem-solving and decision-making techniques, and communicate mathematical ideas.

II. Number, Number Sense and Operations Standard

Students demonstrate number sense, including an understanding of number systems and operations and how they relate to one another. Students compute fluently and make reasonable estimates using paper and pencil, technology-supported and mental methods.

III. Measurement Standard

Students estimate and measure to a required degree of accuracy and precision by selecting and using appropriate units, tools and technologies.

IV. Geometry and Spatial Sense Standard

Students identify, classify, compare and analyze characteristics, properties and relationships of one-, two-, and three-dimensional geometric figures and objects. Students use spatial reasoning, properties of geometric objects, and transformations to analyze mathematical situations and solve problems.

V. Patterns, Functions and Algebra Standard

Students use patterns, relations and functions to model, represent and analyze problem situations that involve variable quantities. Students analyze, model and solve problems using various representations such as tables, graphs and equations.

VI. Data Analysis and Probability Standard

Students pose questions and collect, organize, represent, interpret and analyze data to answer those questions. Students develop and evaluate inferences, predictions and arguments that are based on data.

ALGEBRA

PRE ALGEBRA

ALGEBRA I

Standard I: Mathematical Process

The student will be able to:

- A. Formulate a problem or model in response to a need; determine the information and method needed to solve the problem.
- B. Apply mathematical knowledge and skills routinely in other content areas and practical situations.
- C. Recognize and use connections between equivalent representation and related procedures for a mathematical concept.
- D. Use a variety of mathematical representations to organize, record and communicate ideas.
- E. Use a variety of tools in problem solving.
- F. Write clearly and coherently about mathematical thinking.

*
*
*
*
*
*

*
*
*
*
*
*

Standard II: Number, Number Sense and Operations

The student will be able to:

- A. Use scientific notation to express large numbers and numbers less than one.
- B. Understand the concept of set and subsets of real numbers.
- C. Compute, solve, and explain problems involving square and cube roots.
- D. Estimate, compute, and solve problems involving real numbers.
- E. Connect physical, verbal, and symbolic representations of integers, rational, and irrational numbers.

*
*
*
*

*
*
*
*

Standard III: Measurement

The student will be able to:

- A. Use formulas to solve problems involving area, perimeter, and volume and distance.
- B. Solve increasingly complex non-routine measurement problems and check for reasonableness of the results.
- C. Write and solve real world multi-step problems involving money, elapsed time, temperature, etc.

*
*
*

*
*
*

Standard IV: Geometry & Spatial Sense

The student will be able to:

- A. Use geometric formulas to solve problems.
- B. Use basic trigonometric ratios in right triangles.
- C. Use proportions in various forms to solve problems involving similar figures.

*

*

*

Standard V: Patterns, Functions and Algebra

The student will be able to:

- A. Define function formally and with $f(x)$ notation.
- B. Describe and compare characteristics of families of functions.
- C. Identify functions linear or nonlinear, based on information given in a table, graph or equation.
- D. Solve equations and formulas for a specified variable.
- E. Solve simple linear and nonlinear equations and inequalities having square roots as coefficients and solutions.
- F. Add, subtract, multiply and divide monomials and polynomials.
- G. Graph the quadratic relationship that defines circles.
- H. Solve quadratic equations with real roots by graphing, formula, and factoring.
- I. Use algebraic representations to model and solve problems.
- J. Describe and interpret rates of change from graphical and numerical data.
- K. Solve problems involving a direct and inverse variation.

*

*

*

*

*

*

*

*

*

*

*

*

*

*

*

*

*

Standard VI: Data Analysis and Probability

The student will be able to:

- A. Create a scatter plot and interpret the slope of the line of best fit.
- B. Look at everyday probabilities and uses of statistics in real life.
- C. Compare the characteristics of the mean, median and mode for a given set of data and explain which measure best represents the data.
- D. Analyze and create frequency distribution.
- E. Describe, create and analyze various types of sample spaces and use them to calculate probability.
- F. Differentiate and explain the relationship between probability of an event and the odds of an event and compute one given the other.

*

*

*

*

*

*

*

*

*

*

Geometry

Standard I: Mathematical Process

The student will be able to:

- A. Formulate a problem or mathematical model in response to a specific need or situation, determine information required to solve the problem, choose a method for obtaining this information and set limits for acceptable solutions.
- B. Apply mathematical knowledge and skills routinely in other content areas and practical situations.
- C. Recognize and use connections between equivalent representations and related procedures for a mathematical concept, e.g. zeroes of 2 function and the x-intercept of the graph of the function.
- D. Apply reasoning process and skills to construct logical verifications or counter-examples to test conjectures and to justify and defend algorithms and solutions.
- E. Use a variety of mathematical representations flexibly and appropriately to organize, record and communicate mathematical ideas.
- F. Use precise mathematical language and notations to represent problem situations and mathematical ideas.
- G. Write clearly and coherently about mathematical thinking and ideas.

Standard II: Numbers and Number Sense

The student will be able to:

- A. Use scientific notation to express large numbers and numbers less than one.
- B. Identify subsets of the real number system.
- C. Apply properties of operations and the real number system, and justify when they hold for a set of numbers.
- D. Connect physical, verbal, and symbolic representations of integers, rational numbers, and irrational numbers.

	INFORMAL (BASIC)	GEOMETRY	HONORS GEOMETRY
A.	*	*	*
B.	*	*	*
C.	*	*	*
D.	*	*	*
E.	*	*	*
F.	*	*	*
G.	*	*	*
A.		*	*
B.		*	*
C.			*
D.			*

	INFORMAL (BASIC)	GEOMETRY	HONORS GEOMETRY
A. Solve increasingly complex non-routine measurement problems and check for reasonableness of results.	*	*	*
B. Use formulas to find surface area and volume for specified three-dimensional objects accurate.	*	*	*
C. Apply indirect measurement techniques, tools, and formulas, as appropriate to find perimeter, circumference and area of circles, triangles, quadrilaterals and composite shapes, and to find volume of prism cylinders and pyramids.			*
D. Use proportional reasoning and apply indirect measurement techniques, including right triangle trigonometry and properties of similar triangles, to solve problems involving measurement and rates.	*	*	*
E. Estimate and compute various attributes, including length, angle measure, area, surface area, and volume to a specified level of precision.	*	*	*
Standard IV: <u>Geometry and Spatial Sense</u>			
The student will be able to:			
A. Formally define geometric figures.	*	*	*
B. Describe and apply the properties of similar and congruent figures and justify conjectures involving similarity and congruence.	*	*	*
C. Recognize and apply angle relationships in situations involving intersecting lines, perpendicular lines and parallel lines.	*	*	*
D. Use coordinate geometry to represent and examine the properties of geometric figures.		*	*
E. Draw and construct representations of two- and three- dimensional geometric objects using a variety of tools.	*	*	*
F. Represent and model transformations in a coordinate plane and describe the results.	*	*	*
G. Prove or disprove conjectures and solve problems involving two- and three- dimensional objects represented within a coordinate system.		*	*
H. Establish the validity of conjectures about geometric objects, their properties and relationships by counter example, inductive and deductive reasoning and critiquing arguments made by others.		*	*
I. Use right triangle trigonometric relationships to determine lengths and angle measures.	*	*	*

Standard III: Measurement

The student will be able to:

- A. Solve increasingly complex non-routine measurement problems and check for reasonableness of results.
- B. Use formulas to find surface area and volume for specified three-dimensional objects accurate.
- C. Apply indirect measurement techniques, tools, and formulas, as appropriate to find perimeter, circumference and area of circles, triangles, quadrilaterals and composite shapes, and to find volume of prism cylinders and pyramids.
- D. Use proportional reasoning and apply indirect measurement techniques, including right triangle trigonometry and properties of similar triangles, to solve problems involving measurement and rates.
- E. Estimate and compute various attributes, including length, angle measure, area, surface area, and volume to a specified level of precision.

Standard IV: Geometry and Spatial Sense

The student will be able to:

- A. Formally define geometric figures.
- B. Describe and apply the properties of similar and congruent figures and justify conjectures involving similarity and congruence.
- C. Recognize and apply angle relationships in situations involving intersecting lines, perpendicular lines and parallel lines.
- D. Use coordinate geometry to represent and examine the properties of geometric figures.
- E. Draw and construct representations of two- and three- dimensional geometric objects using a variety of tools.
- F. Represent and model transformations in a coordinate plane and describe the results.
- G. Prove or disprove conjectures and solve problems involving two- and three- dimensional objects represented within a coordinate system.
- H. Establish the validity of conjectures about geometric objects, their properties and relationships by counter example, inductive and deductive reasoning and critiquing arguments made by others.
- I. Use right triangle trigonometric relationships to determine lengths and angle measures.

Standard V: Patterns, Functions and Algebra

The student will be able to:

- A. Generalize and explain patterns and sequences in order to find the next term and the nth term.
- B. Identify and classify functions as linear or nonlinear, and contrast their properties using tables, graphs, or equations.
- C. Translate information from one representation (words, table) to another representation of a relation or function.
- D. Use algebraic representations to model and solve problems.
- E. Analyze and compare functions and their graphs using attributes such as rates of change, intercepts, and zeroes.
- F. Solve and graph linear equations and inequalities.
- G. Solve quadratic equations with real roots by graphing, formula and factoring.
- H. Solve systems of linear equations involving two variables graphically and symbolically.
- I. Model and solve problem situations involving direct and inverse variations.
- J. Describe and interpret rates of change from graphical and numerical data.

Standard VI: Data Analysis & Probability

The student will be able to:

- A. Create, interpret, and use graphical displays and statistical measures to describe data: box- and whisker- plots, histograms, etc.
- B. Evaluate different graphical representations of the same data to determine which is the most appropriate representation for the identified purpose.
- C. Compare the characteristics of the mean, median, and mode for a given set of data and explain which measure of center best represents the data.
- D. Find, use, and interpret measures of center and spread and use those measures to compare and draw conclusions about sets of data.
- E. Evaluate the validity of claims and predictions that are based on data by the appropriateness of the data analysis and collections.
- F. Construct convincing arguments based on analysis of data and interpretation of graphs.
- G. Describe sampling methods and analyze the effects of method chosen on how well the resulting sample represents the population.
- H. Use counting techniques to determine the total number of options and possible outcome.
- I. Design an experiment to test a theoretical probability, and record and explain results.

	INFORMAL (BASIC)	GEOMETRY	HONORS GEOMETRY
A.	*	*	*
B.	*	*	*
C.	*	*	*
D.	*	*	*
E.	*	*	*
F.	*	*	*
G.	*	*	*
H.		*	*
I.	*	*	*
J.		*	*
A.	*	*	*
B.		*	*
C.	*	*	*
D.		*	*
E.	*	*	*
F.		*	*
G.		*	*
H.		*	*
I.		*	*

Integrated Math

Standard I: Mathematical Process

The student will be able to:

- A. Formulate a problem or model, determine information needed to solve the problem and set limits for an acceptable solution.
- B. Apply mathematical skills and knowledge in other content areas and practical situations.
- C. Recognize and use connections between equivalent representations and related procedures for a math concept.
- D. Apply reasoning processes and skills to construct logical verifications.
- E. Use a variety of mathematical representations flexibly and appropriately.
- F. Use precise mathematical language and notations.
- G. Write clearly and coherently about mathematical thinking and ideas.
- H. Locate and interpret mathematical information accurately and communicate ideas, processes and solutions in a complete and early understood manner.
- I. Use various forms of technology where appropriate.

Standard II: Number, Number Sense and Operations

The student will be able to:

- A. Estimate solutions for problem situations involving square and cube roots.
- B. Explain the effects of operations and of computing powers and roots of the magnitude of quantities.
- C. Identify and justify whether properties hold for a given set and operations.
- D. Compare, order and determine equivalent forms for rational and irrational numbers.

Standard III: Measurement

The student will be able to:

- A. Solve problems involving situations involving distances, areas, volumes, and rates within the same measurement system.
- B. Convert rates within the same measurement system.
- C. Use the basics of right triangle trigonometry.
- D. Use ratio of lengths in similar two- and three- dimensional figures to calculate the ratio of areas and volumes.

Standard IV: Geometry and Spatial Sense

The student will be able to:

- A. Define basic trigonometric ratios in right triangles and other key aspects of other geometric figures.
- B. Recognize and explain the necessity for certain terms to remain undefined such as point, line, and plane.
- C. Construct various geometric figures using a compass, straight edge, or technology.
- D. Construct congruent and similar figures using the appropriate tools.
- E. Formally define and explain key aspects of geometric figures.
- F. Make test and establish the validity of conjectures about geometric properties and relationships using proofs, inductive and deductive reasoning.

Standard V: Patterns, Functions and Algebra

The student will be able to:

- A. Define function with ordered pairs.
- B. Find linear equations that represent lines that pass through a given set of ordered pairs.
- C. Solve and interpret that meaning of 2 by 2 systems of linear equations.
- D. Solve linear equations with real roots.
- E. Add, subtract, multiply and divide monomial and polynomials.
- F. Simply rational expressions.

Standard VI: Data Analysis and Probability

The student will be able to:

- A. Use, create and interpret scatter-plots and other types of graphs as appropriate.
- B. Describe how the size of a sample compared to the target population affects the validity of predictions.
- C. Calculate the number of possible outcome for a situation.
- D. Differentiate and explain the relationship between the probability of an event and the odds of an event and compute one given the other.
- E. Represent and analyze bivariate data using appropriate graphical displays.

** indicates that the concept should be taught in course.*

ASSESSMENT

We make the following assumptions when we evaluate:

- instruction and assessment are closely linked;
- good teachers constantly assess students informally and formally;
- teaching mathematics for understanding rests in the teacher's ability to explore topics in ways that promote critical thinking;
- assessments embedded in instruction are important sources of information for instructional and intervention decisions made by teachers and other members of the educational community;
- students must be part of goal setting and evaluation, with self-assessment a vital part of learning;
- formal assessments are stronger if they reflect the content and form of classroom instruction;
- documentation of assessment is important in connecting classroom work to external evaluation.

Assessment techniques may include, but are not limited to:

- traditional tests (objective/subjective);
- quizzes;
- projects (groups and individual);
- problem-solving simulations;
- homework and classwork;
- discussion;
- teacher observations;
- self and peer evaluation;
- pupil-teacher conferences;
- journals;
- student presentations;
- essays;
- research-based reports.

Kindergarten - Mathematics

Standards I: Mathematical Processes.

- A. *Use a variety of tools and strategies in problem solving. I-A*
- B. *Apply mathematical knowledge and skills routinely in other content areas and practical situations. I-B*
- C. *Recognize and use connections between equivalent representations and related procedures. I-C*
- D. *Use a variety of mathematical representations to organize, record, and communicate mathematical ideas. I-E*
- E. *Use mathematical language and symbols to explain mathematical ideas, strategies, and solutions. I-F*

Benchmarks for Standard I:

- **Recognize and demonstrate mathematical vocabulary and relate it to every day language.**
- **Draw pictures and use models to represent problem situations and solutions.**

Standards II: Number, Number Sense and Operations.

- A. Compare and order whole numbers up to 10. II-C
- B. Demonstrate rules of counting, such as each object should be counted once, and that order does not change the number. II-B
- C. Count twenty objects. II-A
- D. Determine "how many" in sets (groups) of 10 or fewer objects. II-A
- E. Relate, read and write numerals 0-10. II-A
- F. Construct multiple sets of objects each containing the same number of objects. II-C
- G. Compare the number of objects in two or more sets when one set has one or two more, or one or two fewer objects. II-C
- H. Represent and use whole numbers in flexible ways; e.g., 5 marbles can be 2 red and 3 green or 1 red and 4 green. II-D

- I. Model and represent addition as combining sets and counting on, and subtraction as take-away. For example: II-A, I-D
 1. Combine and separate small sets of objects in contextual situations; e.g., add or subtract one, two, or another small amount.
 2. Count on (forward) and count back (backward) on a number line between 0 and 10.
- J. Recognize the number or quantity of sets up to 5 without counting; e.g., recognize without counting the dot arrangement on a domino as 5. II-A

Benchmarks for Standard II:

- **Count and recognize whole numbers in a variety of ways.**
- **Draw, write and read numerals and numeral sets.**
- **Recognize, classify, compare and order whole numbers.**

Standard III: Measurement.

- A. Identify units of time (day, week, month, year) and compare calendar elements; e.g., weeks are longer than days. III-A
- B. Identify pennies, nickels and dimes. III-A
- C. Compare and order objects of different lengths, areas, weights and capacities; and use relative terms, such as longer, shorter, bigger, smaller, heavier, lighter, more and less. III-E
- D. Measure length and volume (capacity) using uniform objects in the environment. For example, find: III-C
 1. how many paper clips long is a pencil;
 2. how many small containers it takes to fill one big container using sand, rice, beans.
- E. Order events based on time. For example: III-E
 1. activities that take a long or short time;
 2. review what we do first, next, last;
 3. recall what we did or plan to do yesterday, today, tomorrow.
- F. *Tell time to the hour on an analog and digital clock. III-C*

Benchmark for Standard III:

- **Use non-standard units of measure.**

Standard IV: Geometry and Spatial Sense.

- A. Identify and sort two-dimensional shapes (paper shapes) and three-dimensional objects (blocks, real objects). For example: IV-A,G
 1. Identify and describe two-dimensional figures and three-dimensional objects from the environment using the child's own vocabulary.
 2. Select and sort shapes and objects into groups based on student-defined categories.
 3. Build two-dimensional figures using paper shapes or tangrams; build simple three-dimensional objects using blocks.
 4. Select all shapes or objects of one type from a group.
- B. Name and demonstrate the relative position of objects as follows: IV-A
 1. place objects over, under, inside, outside, on, beside, between, above, below, on top of, upside-down, behind, in back of, in front of.
 2. describe placement of objects with terms, such as on, inside, outside, above, below, over, under, beside, between, in front of, behind.

Benchmarks for Standard IV:

- **Recognize plane figures: circle, rectangle, square, triangle, rhombus and ellipse, and identify them in the environment.**
- **Describe location, using comparative (before, after), directional (above, below), and positional (first, last) words.**

Standard V: Patterns, Functions and Algebra.

- A. Sort, classify and order objects by size, number and other properties. For example: V-A
1. Identify how objects are alike and different.
 2. Order three events or objects according to a given attribute, such as time or size.
 3. Recognize and explain how objects can be classified in more than one way.
 4. Identify what attribute was used to sort groups of objects that have already been sorted.
- B. Identify, create and extend patterns of sounds, shapes (such as buttons, leaves or blocks), motions (such as hops or skips), and numbers from 1 to 10. V-B
- C. Describe orally the pattern of a given sequence. V-B
- D. Model a problem situation using physical materials. V-F, I-D

Benchmarks for Standard V:

- **Sort, classify and order objects by size, number and other properties and describe the attributes used.**
- **Recognize, describe, extend and create patterns.**

Standard VI: Data Analysis and Probability.

- A. Gather and sort data in response to questions posed by teacher and students; e.g., how many sisters and brothers, what color shoes. VI-A
- B. Arrange objects in a floor or table graph according to attributes, such as use, size, color or shape. VI-B
- C. Select the category or categories that have the most, fewest, or equal number of objects in a floor or table graph. VI-C

Benchmark for Standard VI:

- **Pose questions and gather data about everyday situations and familiar objects.**

Key to using this document:

- **Items in bold with Roman numerals are COS standards.**

- **Items in bold without Roman numerals are benchmarks.**

- Items in regular print are state grade level indicators with the COS letter/number correlation.

- *Items in italics reference the Diocesan COS objectives that are not in state standards.*

Grade 1 - Mathematics

Standards I: Mathematical Processes.

- A. *Use a variety of tools and strategies in problem solving. I-A*
- B. *Apply mathematical knowledge and skills routinely in other content areas and practical situations. I-B*
- C. *Recognize and use connections between equivalent representations and related procedures. I-C*
- D. *Evaluate the reasonableness of predictions, estimations and solutions. I-D*
- E. *Use a variety of mathematical representations to organize, record, and communicate mathematical ideas. I-E*
- F. *Use mathematical language and symbols to explain mathematical ideas, strategies, and solutions. I-F*
- G. *Orally explain simple mathematical thinking and ideas. I-G*

Benchmarks for Standard I:

- **Model, represent, and explain a variety of strategies in problem solving.**
- **Explain in own words information needed to problem solve.**
- **Explain how a problem was solved by using pictures and models.**
- **Use conventional symbols and common language to describe a problem.**
- **Recognize the mathematical meanings of common words and how they relate to mathematical processes.**

Standards II: Number, Number Sense and Operations.

- A. Demonstrate joining multiple groups of objects, each containing the same number of objects; e.g., combining 3 bags of candy, each containing 2 pieces. II-B
- B. Partition or share a small set of objects into groups of equal size; e.g., sharing 6 stickers equally among 3 children. II-B
- C. Use ordinal numbers to order objects; e.g., first, second, third. II-C

- D. Recognize and generate equivalent forms for the same number using physical models, words and number expressions; e.g., concept of ten is described by "10 blocks," full tens frame, numeral 10, $5 + 5$, $15 - 5$, one less than 11, my brother's age. II-C, I-E
- E. Read and write the numerals for numbers to 100. II-A
- F. Count forward to 100, count backwards from 100, and count forward or backward starting at any number between 1 and 100. II-A
- G. Use place value concepts to represent whole numbers using numerals, words, expanded notation and physical models with ones and tens. For example: II-A, I-D,E
 1. Develop a system to group and count by twos, fives and tens.
 2. Identify patterns and groupings in a 100's chart and relate to place value concepts.
 3. Recognize the first digit of a two-digit number as the most important to indicate size of a number and the nearness to 10 or 100.
- H. Represent commonly used fractions using words and physical models for halves, thirds and fourths, recognizing fractions are represented by equal size parts of a whole and of a set of objects. II-A, I-E
- I. Model, represent and explain addition as putting together sets (part + part = whole) and counting on. For example: II,A,B, I-E
 1. Model and explain addition using physical materials in contextual situations.
 2. Draw pictures to model addition.
 3. Write number sentences to represent addition.
 4. Explain that adding two whole numbers yields a larger whole number.
- J. Model, represent and explain subtraction as take-away and comparison. For example: II-A,B, I-A
 1. Model and explain subtraction using physical materials in contextual situations.
 2. Draw pictures to model subtraction.
 3. Write number sentences to represent subtraction.
 4. Explain that subtraction of whole numbers yields an answer smaller than the original number.

- K. Use conventional symbols to represent the operations of addition and subtraction. II-A, I-F
- L. Model and represent multiplication as repeated addition and rectangular arrays in contextual situations; e.g., four people will be at my party and if I want to give 3 balloons to each person, how many balloons will I need to buy? II-A,B
- M. Model and represent division as sharing equally in contextual situations; e.g., sharing cookies. II-A, B, I-E
- N. Demonstrate that equal means "the same as," using visual representations. II-A, I-E
- O. Develop strategies for basic addition facts, such as: II-B, D
 1. counting all;
 2. counting on;
 3. one more, two more;
 4. doubles;
 5. doubles plus or minus one;
 6. make ten;
 7. using tens frames;
 8. identity property (adding 0).
- P. Develop strategies for basic subtraction facts, such as: II-B,D
 1. relating to addition (for e.g., think of $7 - 3 = ?$ as $3 + ? = 7$);
 2. one less, two less;
 3. all but one (e.g., $8 - 7$, $5 - 4$);
 4. using tens frames;
 5. missing addends.
- Q. Model, explain and master operations (addition and subtraction) with basic facts (0-10). II-B
- R. Recognize and classify numbers as even or odd. II-B

Benchmarks for Standard II:

- **Model, explain and master operations (addition and subtraction) with basic facts (0-10).**
- **Compare and combine groups of objects.**
- **Count, read and write numbers to 100 in a variety of ways.**
- **Model, represent, explain and develop strategies for addition and subtraction concepts.**

- **Add and subtract two digit numbers without regrouping.**
- **Represent commonly used fractions using words and physical models.**
- **Count using numerals and ordinal numbers.**

Standard III: Measurement.

- Identify and state the value of a penny, nickel, dime, quarter and dollar. III-A
- Determine the value of a small collection of coins (with a total value up to one dollar) using 1 or 2 different type coins, including pennies, nickels, dimes and quarters. III-A
- Show different combinations of coins that have the same value. III-A
- Recognize and explain the need for fixed units and tools for measuring length and weight; e.g., rulers and balance scales. III-A
- Tell time to the nearest hour, half hour and *quarter hour*. III-C
- Order a sequence of events with respect to time; e.g., summer, fall, winter and spring; morning, afternoon and night. III-E
- Estimate and measure weight using non-standard units; e.g., blocks of uniform size. III-C
- Estimate and measure lengths using non-standard and standard units; i.e., centimeters, inches and feet. III-C

Benchmark for Standard III:

- **Explain the need for standard units of measure.**

Standard IV: Geometry and Spatial Sense.

- Identify, compare and sort two-dimensional shapes; i.e., square, circle, ellipse, triangle, rectangle, rhombus, and pentagon. For example: IV-A,G
 - Recognize and identify triangles and rhombuses independent of position, shape or size;
 - Describe two-dimensional shapes using attributes such as number of sides and number of vertices (corners or angles).
- Create new shapes by combining or cutting apart existing shapes. IV-F
- Identify the shapes of the faces of three-dimensional objects. IV-A,G

- Extend the use of location words to include distance (near, far, close to) and directional words (left, right). IV-A
- Locate coordinate points on a grid using directional words (right 2, up 1).* IV-A
- Copy figures and draw simple two-dimensional shapes from memory. IV-E

Benchmark for Standard IV:

- **Sort and compare two-dimensional figures and three-dimensional objects according to their characteristics and properties.**

Standard V: Patterns, Functions and Algebra.

- Sort, classify and order objects by two or more attributes, such as color and shape, and explain how objects were sorted. V-A
- Extend sequences of sounds, shapes or simple number patterns, and create and record similar patterns *in a table or a list*. For example, continue repeating and growing patterns with materials, pictures and geometric items; e.g., XO, XOO, XOOO, XOOOO. V-B
- Describe orally the basic unit or general plan of a repeating or growing pattern. V-B
- Describe orally and model a problem situation using words, objects or number phrase or sentence. V-F
- Solve open sentences and explain strategies. V-I

Benchmarks for Standard V:

- **Extend sequences of sounds and shapes or simple number patterns, and create and record similar patterns.**
- **Model problem situations, using objects, pictures, numbers and other symbols.**
- **Solve open sentences and explain strategies.**

Standard VI: Data Analysis and Probability.

- Identify multiple categories for sorting data. VI-A
- Collect and organize data into charts using tally marks. VI-C
- Display data in picture graphs with units of 1 and bar graphs with intervals of 1. VI-B

- Read and interpret charts, picture graphs and bar graphs as sources of information to identify main ideas, draw conclusions, and make predictions. VI-C
- Construct a question that can be answered by using information from a graph. VI-D
- Arrange five objects by an attribute, such as size or weight, and identify the ordinal position of each object. VI-A
- Answer questions about the number of objects represented in a picture graph, bar graph or table graph; e.g., category with most, how many more in a category compared to another, how many altogether in two categories. VI-C
- Describe the likelihood of simple events as possible/impossible and more likely/less likely; e.g., when using spinners or number cubes in classroom activities. VI-G

Benchmark for Standard VI:

- **Sort and classify objects by attributes, and organize data into categories in a simple table or chart.**

Key to using this document:

- **Items in bold with Roman numerals are COS standards.**
- **Items in bold without Roman numerals are benchmarks.**
- Items in regular print are state grade level indicators with the COS letter/number correlation.
- *Items in italics reference the Diocesan COS objectives that are not in state standards.*

Grade 2 - Mathematics

Standards I: Mathematical Processes.

- A. *Use a variety of tools and strategies in problem solving. I-A*
- B. *Apply mathematical knowledge and skills routinely in other content areas and practical situations. I-B*
- C. *Recognize and use connections between equivalent representations and related procedures. I-C*
- D. *Evaluate the reasonableness of predictions, estimations and solutions. I-D*
- E. *Use a variety of mathematical representations to organize, record, and communicate mathematical ideas. I-E*
- F. *Use mathematical language and symbols to explain mathematical ideas, strategies, and solutions. I-F*
- G. *Explain orally mathematical thinking and ideas. I-G*

Benchmarks for Standard I:

- **Use alternative strategies to problem solve.**
- **Use conventional symbols and common language to describe a problem situation and solution.**
- **Evaluate the reasonableness of predictions, estimations and solutions.**
- **Communicate and/or write in own words strategies to solve a problem.**

Standards II: Number, Number Sense and Operations.

- A. Use place value concepts to represent, compare and order whole numbers using physical models, numerals and words, with ones, tens and hundreds. For example: II-C
 1. Recognize 10 can mean "10 ones" or a single entity (1 ten) through physical models and trading games.
 2. Read and write 3-digit numerals (e.g., 243 as two hundred forty three, 24 tens and 3 ones, or 2 hundreds and 43 ones, etc.) and construct models to represent each.
- B. Represent fractions (halves, thirds, and

fourths), using words, numerals and physical models. For example: II-A, I-E

1. Recognize that a fractional part can mean different amounts depending on the original quantity.
 2. Recognize that a fractional part of a rectangle does not have to be shaded with contiguous parts.
 3. Identify and illustrate parts of a whole and parts of sets of objects.
 4. Compare and order physical models of $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$ in relation to 0 and 1.
- C. Model, represent and explain subtraction as comparison, take-away and part-to-whole; e.g., solve missing addend problems by counting up or subtracting, such as "I had six baseball cards, my sister gave me more, and I now have ten. How many did she give me?" can be represented as $6 + ? = 10$ or $10 - 6 = ?$. II-A,B, I-E
 - D. Model, represent and explain multiplication as repeated addition, rectangular arrays and skip counting. II-A,B, I-E
 - E. Model, represent and explain division as sharing equally and repeated subtraction. II-A,B, I-E
 - F. Model and use the commutative property for addition. II-B, I-E
 - G. Demonstrate fluency in addition facts with addends through 9 and corresponding subtractions; e.g., $9 + 9 = 18$, $18 - 9 = 9$. II-B,D
 - H. Add and subtract multiples of 10. II-B,D
 - I. Demonstrate multiple strategies for adding and subtracting 2- or 3-digit whole numbers, such as: II-D
 1. compatible numbers;
 2. compensatory numbers;
 3. informal use of commutative and associative properties of addition.
 - J. Add and subtract 2-digit numbers with and without regrouping. II-B,D
 - K. Estimate the results of whole number addition and subtraction problems using front-end estimation, and judge the reasonableness of the answers.

Benchmarks for Standard II:

- **Use place value concepts to represent whole numbers using numerals, words and physical models.**
- **Recognize, classify, compare and order whole numbers.**
- **Model, explain and master operations (addition and subtraction) with basic facts 0-18.**
- **Add and subtract 2-digit numbers with and without regrouping.**
- **Demonstrate fluency in adding and subtracting multiples of 10, and recognize combinations that make 10.**

Standard III: Measurement.

- A. Identify and select appropriate units of measure for: III-A,B
 1. length – centimeters, meters, inches, feet or yards;
 2. volume (capacity) – liters, cups, pints or quarts;
 3. weight – grams, ounces or pounds;
 4. time – hours, half-hours, quarter-hours or minutes and time designations, a.m. or p.m.
- B. Establish personal or common referents for units of measure to make estimates and comparisons; e.g., the width of a finger is a centimeter, a large bottle of soda pop is 2 liters, a small paper clip weighs about one gram. III-D
- C. Describe and compare the relationships among units of measure, such as centimeters and meters; inches, feet and yards; cups, pints and quarts; ounces and pounds; and hours, half-hours, and quarter-hours; e.g., how many inches in a foot? III-D
- D. Tell time to the nearest minute interval on digital and to the nearest 5 minute interval on analog (dial) timepieces. III-C
- E. Estimate and measure the length and weight of common objects, using metric and U.S. customary units, accurate to the nearest unit. III-C

- F. Select and use appropriate measurement tools; e.g., a ruler to draw a segment 3 inches long, a measuring cup to place 2 cups of rice in a bowl, a scale to weigh 50 grams of candy. III-C
- G. Make and test predictions about measurements, using different units to measure the same length or volume. III-B
- H. Represent and write the value of money using the ¢ sign and in decimal form when using the \$ sign. II-A
- I. Count money and make change using coins and a dollar bill.

Benchmarks for Standard III:

- **Select appropriate units for length, weight, volume and time, using: objects; i.e., non-standard units; U.S. customary units: inch, foot, ounce, pound, cup, quart, gallon, minutes, hour, day, week and year; metric units: centimeter, meter, gram and liter.**
- **Develop common referents for units of measure for length, weight, volume, and time to make comparisons and estimates.**
- **Apply measurement techniques to measure length, weight and volume.**
- **Recognize that using different units of measurement will yield different numbers for the same measurement.**
- **Determine the value of a collection of coins and dollar bills.**

Standard IV: Geometry and Spatial Sense.

- A. Identify, describe, compare and sort two and three-dimensional objects (i.e., cubes, spheres, prisms, cones, cylinders, pentagon, hexagon and pyramids). IV-A,G
- B. Predict what new shapes will be formed by combining or cutting apart existing shapes. IV-F
- C. Recognize two-dimensional shapes and three-dimensional objects from different positions. IV-A

- D. Create and identify two-dimensional figures with line symmetry; e.g., what letter shapes, logos, polygons are symmetrical? IV-A,E

Benchmarks for Standard IV:

- **Describe and create plane figures; circle, rectangle, square, triangle, hexagon, trapezoid, parallelogram and rhombus, and identify them in the environment.**
- **Describe solid objects: cube, rectangular prism, sphere, cylinder, cone and pyramid, and identify them in the environment.**
- **Recognize two- and three-dimensional objects from different positions.**
- **Identify and draw figures with line symmetry.**

Standard V: Patterns, Functions and Algebra.

- A. Solve open sentences by representing an expression in more than one way using the commutative property; e.g., $4 + 5 = 5 + 4$ or the number of blue balls plus red balls is the same as the number of red balls plus blue balls ($R + B = B + R$). V-G
- B. Extend simple number patterns (both repeating and growing patterns), and create similar patterns using different objects, such as using physical materials or shapes to represent numerical patterns. V-B
- C. Use patterns to make generalizations and predictions; e.g., determine a missing element in a pattern. V-B
- D. Create new patterns with consistent rules or plans, and describe the rule or general plan of existing patterns. V-C
- E. Use objects, pictures, numbers and other symbols to represent a problem situation. V-F
- F. Understand equivalence and extend the concept to situations involving symbols; e.g., $4 + 5 = 9$ and $9 = 4 + 5$, and $4 + 5 = 3 + 6 = \Delta + \square \dots$ V-G
- G. Use symbols to represent unknown quantities and identify values for

symbols in an expression or equation using addition and subtraction; e.g., $\square + O = 10$, $\Delta - 2 = 4$. V-G

Benchmarks of Standard V:

- **Represent an unknown quantity as a variable using a symbol such as \square , Δ , O .**

Standard VI: Data Analysis and Probability.

- A. Pose questions, use observations, interviews and surveys to collect data, and organize data in charts, picture graphs and bar graphs. VI-A
- B. Read, interpret and make comparisons and predictions from data represented in charts, line plots, picture graphs and bar graphs. VI-C
- C. Read and construct simple timelines to sequence events. VI-A
- D. Write a few sentences to describe and compare categories of data represented in a chart or graph, and make statements about the data as a whole. VI-C
- E. Identify untrue or inappropriate statements about a given set of data. VI-C
- F. Recognize that data may vary from one population to another; e.g., favorite TV shows of students and of parents. VI-E
- G. List some of the possible outcomes of a simple experiment, and predict whether given outcomes are more, less or equally likely to occur. VI-F
- H. Use physical models and pictures to represent possible arrangements of 2 or 3 objects. VI-B

Benchmarks for Standard VI:

- **Represent data using objects, picture graphs and bar graphs.**
- **Describe the probability of chance events as more, less or equally likely to occur.**

Key to using this document:

- **Items in bold with Roman numerals are COS standards.**
- **Items in bold without Roman numerals are benchmarks.**
- Items in regular print are state grade level indicators with the COS letter/number correlation.
- *Items in italics reference the Diocesan COS objectives that are not in state standards.*

Grade 3 - Mathematics

Standards I: Mathematical Processes.

- A. *Use a variety of tools and strategies in problem solving. I-A*
- B. *Apply mathematical knowledge and skills routinely in other content areas and practical situations. I-B*
- C. *Recognize and use connections between equivalent representations and related procedures. I-C*
- D. *Evaluate the reasonableness of predictions, estimations and solutions. I-D*
- E. *Use a variety of mathematical representations to organize, record, and communicate mathematical ideas. I-E*
- F. *Use mathematical language and symbols to explain and justify mathematical ideas, strategies, and solutions. I-F*
- G. *Write simple explanations about mathematical thinking and ideas. I-G*

Benchmarks for Standard I:

- **Apply and justify the use of a variety of problem-solving strategies; e.g., make an organized list, guess and check.**
- **Use an organized approach and appropriate strategies to solve multi-step problems.**
- **Link concepts to procedures and to symbolic notation; e.g., model 3×4 with a geometric array, represent $1/3$ by dividing an object into three equal parts.**
- **Interpret results in the context of the problem being solved; e.g., the solution must be a whole number of buses when determining the number of buses necessary to transport students.**
- **Use mathematical strategies to solve problems that relate to other curriculum areas and the real world; e.g., use a timeline to sequence events; use symmetry in artwork.**
- **Recognize relationships among different topics within mathematics; e.g., the length of an object can be represented by a number.**

Standards II: Number, Number Sense and Operations.

- A. Identify and generate equivalent forms of whole numbers; e.g., 36 , $30 + 6$, 9×4 , $46 - 10$, number of inches in a yard. II-C
- B. Use place value concepts to represent whole numbers and decimals using numerals, words, expanded notation and physical models. For example: II-C
 1. Recognize 100 means "10 tens" as well as a single entity (1 hundred) through physical models and trading games.
 2. Describe the multiplicative nature of the number system; e.g., the structure of 3205 as 3×1000 plus 2×100 plus 5×1 .
 3. Model the size of 1000 in multiple ways; e.g., packaging 1000 objects into 10 boxes of 100, modeling a meter with centimeter and decimeter strips, or gathering 1000 pop-can tabs.
 4. Explain the concept of tenths and hundredths using physical models, such as metric pieces, base ten blocks, decimal squares or money.
- C. Use mathematical language and symbols to compare and order; e.g., less than, greater than, at most, at least, $<$, $>$, $=$, \leq , \geq . II-A
- D. Represent fractions, including $1/6$ and $1/8$, and mixed numbers using words, numerals and physical models. II-A
- E. Compare and order commonly used fractions and mixed numbers using number lines, models (such as fraction circles or bars), points of reference (such as more or less than $1/2$), and equivalent forms using physical or visual models. II-C
- F. Recognize and use decimal and fraction concepts and notations as related ways of representing parts of a whole or a set; e.g., 3 of 10 marbles are red can also be described as $3/10$ and 3 tenths are red. II-A,C
- G. Model, represent and explain multiplication; e.g., repeated addition, skip counting, rectangular arrays and area model. For example: II-A,B
 1. Use conventional mathematical symbols to write equations for word problems involving multiplication.

2. Understand that, unlike addition and subtraction, the factors in multiplication and division may have different units; e.g., 3 boxes of 5 cookies each.
- H. Model, represent and explain division; e.g., sharing equally, repeated subtraction, rectangular arrays and area model. For example: II-A,B
 1. Translate contextual situations involving division into conventional mathematical symbols.
 2. Explain how a remainder may impact an answer in a real-world situation; e.g., 14 cookies being shared by 4 children.
- I. Explain and use relationships between operations, such as: II-B
 1. relate addition and subtraction as inverse operations;
 2. relate multiplication and division as inverse operations;
 3. relate addition to multiplication (repeated addition);
 4. relate subtraction to division (repeated subtraction).
- J. Model and use the commutative and associative properties for addition and multiplication. II-B
- K. Demonstrate fluency in multiplication facts through 10 and corresponding division facts. II-B,D
- L. Multiply and divide 2- and 3-digit numbers by a single-digit number, without remainders for division. II-B,D
- M. Evaluate the reasonableness of computations based upon operations and the numbers involved; e.g., considering relative size, place value and estimates. II-B,D
- N. Use a variety of methods and appropriate tools for computing with whole numbers; e.g., mental math, a pen and pencil and calculator. II-D
- O. *Estimate and compute fluently. I-H*

Benchmarks for Standard II:

- **Model, represent and explain multiplication as repeated addition, rectangular arrays, and skip counting.**

- **Model, represent and explain division as sharing equally, repeated subtraction and rectangular arrays.**
- **Model and use commutative property for addition and multiplication.**
- **Use relationships between operations, such as subtraction as the inverse of addition and division as the inverse of multiplication.**
- **Demonstrate fluency in multiplication facts with factors through ten and corresponding division factors.**
- **Use a variety of methods and appropriate tools (mental math, paper and pencil, calculator) for computing with whole numbers.**

Standard III: Measurement.

- A. Identify and select appropriate units for measuring: III-A,B
1. length – miles, kilometers and other units of measure as appropriate;
 2. volume (capacity) – gallons;
 3. weight – ounces, pounds, grams, or kilograms;
 4. temperature – degrees (Fahrenheit or Celsius).
- B. Establish personal or common referents to include additional units; e.g., a gallon container of milk; a postage stamp is about a square inch. III-D
- C. Tell time to the nearest minute and find elapsed time using a calendar or a clock. III-C
- D. Read thermometers in both Fahrenheit and Celsius scales. III-D
- E. Measure length, weight and volume (capacity), using metric and U.S. customary units, $\frac{1}{2}$ or $\frac{1}{4}$ unit as appropriate. III-A,B
- F. Choose and use appropriate measurement tools. III-C
- G. Count and make change up to one dollar.

Benchmarks for Standard III:

- **Tell time to the nearest minute.**
- **Make change using coins and paper money for values up to one dollar.**

Standard IV: Geometry and Spatial Sense.

- A. Identify, compare and sort two-dimensional shapes including trapezoid and parallelogram. II-A,G

- B. Analyze and describe properties of two dimensional shapes and three-dimensional objects using terms such as vertex, edge, angle, side and face. IV- A,G
- C. Identify and describe the relative size of angles with respect to right angles as follows: IV-D
1. Use physical models, like straws, to make different sized angles by opening and closing the sides, not by changing the side lengths.
 2. Identify right, acute, obtuse and straight angles.
- D. Find and name locations on a labeled grid or coordinate system; e.g., a map or graph. IV-B
- E. Identify and determine whether two-dimensional shapes are congruent (same shape and size) or similar (same shape different size) by copying or using superposition (lay one thing on top of another). IV-A
- F. Build a three-dimensional model of an object composed of cubes; e.g., construct a model based on an illustration or actual object. IV-E

Benchmarks for Standard IV:

- **Provide rationale for groupings and comparisons of two-dimensional figures and three-dimensional objects.**
- **Use attributes to describe, classify and sketch plane figures and build solid objects.**
- **Find and name locations in coordinate systems.**
- **Describe a motion that shows 2 shapes are similar or congruent.**

Standard V: Patterns, Functions and Algebra.

- A. Extend multiplicative and growing patterns, and describe the pattern or rule in words. V-A,G
- B. Analyze and replicate arithmetic sequences with and without a calculator. V-B
- C. Use patterns to make predictions, identify relationships, and solve problems. V-B,H
- D. Model problem situations using objects, pictures, tables, numbers, letters and other symbols. V-C,H
- E. Write, solve and explain simple mathematical statements, such as $7 + \square > 8$ or $\Delta + 8 = 10$. V-I
- F. Express mathematical relationships as equations

and inequalities. V-D,J

- G. Create tables to record, organize and analyze data to discover patterns and rules. V-C,E,H
- H. Identify and describe qualitative and quantitative changes, especially those involving addition and subtraction; e.g., the height of water in a glass becoming one centimeter lower each week due to evaporation. V-F,K

Benchmarks for Standard V:

- **Analyze and extend patterns, and describe the rule in words.**
- **Describe and compare qualitative and quantitative changes.**
- **Use patterns to make predictions, identify relationships, and solve problems.**

Standard VI: Data Analysis and Probability.

- A. Collect and organize data from an experiment, such as recording and classifying observations or measurements, in response to a question posed. VI-A
- B. Draw and interpret picture graphs in which a symbol or picture represents more than one object. VI-B
- C. Read, interpret and construct bar graphs with intervals greater than one. VI-B
- D. Support a conclusion or prediction orally and in writing, using information in a table or graph. VI-F
- E. Match a set of data with a graphical representation of the data. VI-D
- F. Translate information freely among charts, tables, line plots, picture graphs and bar graphs; e.g., create a bar graph from the information in a chart. VI-B
- G. Analyze and interpret information represented on a timeline. VI-C
- H. Identify the mode of a data set and describe the information it gives about a data set. VI-C
- I. Conduct a simple experiment or simulation of a simple event, record the results in a chart, table or graph, and use the results to draw conclusions about the likelihood of possible outcomes. VI-G,H
- J. Use physical models, pictures, diagrams and lists to solve problems involving possible arrangements or combinations of two to four objects. VI-B

Benchmark for Standard VI:

- **Gather and organize data from surveys and classroom experiments, including data collected over a period of time.**
- **Construct charts, tables and graphs to represent data, including picture graphs and bar graphs.**
- **Read and interpret tables, charts, graphs (bar, picture, line, line plot), and timelines as sources of information, and identify main idea, draw conclusions and make predictions.**

Key to using this document:

- **Items in bold with Roman numerals are COS standards.**

- **Items in bold without Roman numerals are benchmarks.**

- Items in regular print are state grade level indicators with the COS letter/number correlation.

- *Items in italics reference the Diocesan COS objectives that are not in state standards.*

Grade 4 - Mathematics

Standards I: Mathematical Processes.

- A. *Use a variety of tools and strategies in problem solving. I-A*
- B. *Apply mathematical knowledge and skills routinely in other content areas and practical situations. I-B*
- C. *Recognize and use connections between equivalent representations and related procedures. I-C*
- D. *Evaluate the reasonableness of predictions, estimations and solutions. I-D*
- E. *Use a variety of mathematical representations to organize, record, and communicate mathematical ideas. I-E*
- F. *Use mathematical language and symbols to explain, analyze, and justify mathematical ideas, strategies, and solutions. I-F*
- G. *Write clearly and coherently about mathematical thinking and ideas. I-G*

Benchmarks for Standard I:

- **Use reasoning skills to determine and explain the reasonableness of a solution with respect to the problem situation.**
- **Represent problem situations in a variety of forms (physical model, diagram, in words or symbols), and recognize when some ways of representing a problem may be more helpful than others.**
- **Read, interpret, discuss and write about mathematical ideas and concepts using both everyday and mathematical language.**
- **Begin to use mathematical language to explain and justify mathematical ideas, strategies and solutions.**

Standards II: Number, Number Sense and Operations.

- A. Identify and generate equivalent forms of fractions and decimals. For example: II-C

1. Connect physical, verbal and symbolic representations of fractions, decimals and whole numbers; e.g., $\frac{1}{2}$, $\frac{5}{10}$, "five tenths," 0.5, shaded rectangles with half, and five tenths.
2. Understand and explain that $\frac{10}{10}$ is the same as one whole in both fraction and decimal form.
- B. Use place value structure of the base-ten number system to read, write, represent and compare whole numbers through millions and decimals through thousandth. II-C
- C. Round whole numbers to a given place value. II-D
- D. Use models and points of reference to compare commonly used fractions. II-C, I-E
- E. Use associative and distributive properties to simplify and perform computations; e.g., use left to right multiplication and the distributive property to find an exact answer without paper and pencil, such as $5 \times 47 = 5 \times 40 + 5 \times 7 = 200 + 35 = 235$. II-B,D
- F. Recognize that division may be used to solve different types of problem situations and interpret the meaning of remainders; e.g., situations involving measurement, money. II-B,D
- G. Estimate the results of computations involving whole numbers, fractions and decimals, using a variety of strategies. II-D
- H. Use physical models, visual representations, and paper and pencil to add and subtract decimals and commonly used fractions with like denominators. II-A,B,D, I-E
- I. Develop and explain strategies for performing computations mentally. II-D
- J. 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. II-D
- K. Demonstrate fluency in adding and subtracting whole numbers and develop skills in multiplying and dividing whole numbers by one and two digit numbers and multiples of ten. II-B,D

Benchmarks for Standard II:

- **Estimate the results of whole number computations using a variety of strategies, and judge reasonableness.**
- **Represent commonly used fractions and mixed numbers using words and physical models.**
- **Analyze and solve multi-step problems involving addition, subtraction, multiplication and division of whole numbers.**
- **Add and subtract commonly used fractions with like denominators and decimals, using models and paper and pencil.**

Standard III: Measurement.

- A. Solve problems involving counting money and making change, using both coins and paper bills. III-A
- B. Relate the number of units to the size of the units used to measure an object; e.g., compare the number of cups to fill a pitcher to the number of quarts to fill the same pitcher. III-D
- C. Demonstrate and describe perimeter as "distance around" and area as covering a two-dimensional shape, and volume as filling a three-dimensional object. III-C
- D. Identify and select appropriate units to measure: III-A,B
 1. perimeter – string or links (inches or centimeters).
 2. area – tiles (square inches or square centimeters).
 3. volume – cubes (cubic inches or cubic centimeters).
- E. Develop and use strategies to find perimeter using string or links, area using tiles or a grid, and volume using cubes; e.g., count squares to find area of regular or irregular shapes on a grid, layer cubes in a box to find its volume. III-D
- F. Make simple unit conversions within a measurement system; e.g., inches to feet, kilograms to grams, quarts to gallons. III-D

Benchmarks for Standard III:

- **Select appropriate units for perimeter, area, weight, volume, time and temperature, using: objects of uniform size; U.S. customary units, e.g. mile, square inch, cubic inch, second, degree Fahrenheit, and other units as appropriate; metric units; e.g., millimeter, kilometer, square centimeter, kilogram, cubic centimeter, degree Celsius, and other units as appropriate.**
- **Know that the number of units is inversely related to the size of the unit for any item being measured.**
- **Develop common referents for units of measure for length, weight, volume and time to make comparisons and estimates.**
- **Identify appropriate tools and apply counting techniques for measuring side lengths, perimeter and area of squares, rectangles, and simple irregular two-dimensional shapes, volume of rectangular prisms, and time and temperature.**

Standard IV: Geometry and Spatial Sense.

- A. Identify, describe and model intersecting, parallel and perpendicular lines and line segments; e.g., use straws or other material to model lines. IV-A,G
- B. Describe, classify, compare and model two- and three-dimensional objects using their attributes. IV-A
- C. Identify similarities and differences of quadrilaterals; e.g., squares, rectangles, parallelograms and trapezoids. IV-A,G
- D. Identify and define triangles based on angle measures (equiangular, right, acute and obtuse triangles) and side lengths (isosceles, equilateral and scalene triangles). IV-D,G
- E. Describe points, lines and planes, and identify models in the environment. IV-C,G
- F. Specify locations and plot ordered pairs on a coordinate plane, using first quadrant points. IV-B
- G. Identify and describe line symmetry in 2-dimensional shapes and designs. IV-F

- H. Use geometric models to solve problems in other areas of mathematics, such as number (multiplication/division) and measurement (area, perimeter, border). IV-I, I-E

Benchmarks for Standard IV:

- **Describe and identify points, lines and planes in the environment.**
- **Describe and identify intersecting, parallel and perpendicular lines or segments in the environment.**
- **Identify and classify right, obtuse, acute and straight angles.**
- **Develop definitions of classes of shapes.**
- **Identify and describe line symmetry in two-dimensional shapes and designs.**

Standard V: Patterns, Functions and Algebra.

- A. Use models and words to describe, extend and make generalizations of patterns and relationships occurring in computation, numerical patterns, geometry, graphs and other applications. V-B, I-E
- B. Represent and analyze patterns and functions using words, tables and graphs. V-D
- C. Use rules and variables to describe patterns and other relationships. V-G
- D. Represent mathematical relationships with equations or inequalities. V-D,J

Benchmarks for Standard V:

- **Write and solve open sentences and explain strategies.**
- **Represent an unknown quantity as a variable using a symbol, including letters.**
- **Use variables to create and solve equations representing problem situations.**

Standard VI: Data Analysis and Probability.

- A. Create a plan for collecting data for a specific purpose. VI-A
- B. Represent and interpret data using tables, bar graphs, line plots and line graphs. VI-B
- C. Interpret and construct Venn diagrams to sort and describe data. VI-B,C

- D. Compare different representations of the same data to evaluate how well each representation shows important aspects of the data, and identify appropriate ways to display the data. VI-B,C
- E. Propose and explain interpretations and predictions based on data displayed in tables, charts and graphs. VI-C,F
- F. Identify the range, median and mode in a set of data. VI-C
- G. Conduct simple probability experiments and draw conclusions from the results; e.g., rolling number cubes or drawing marbles from a bag. VI-G
- H. Represent the likelihood of possible outcomes for chance situations; e.g., probability of selecting a red marble from a bag containing 3 red and 5 white marbles. VI-F
- I. List and count all possible combinations using one member from each of several sets, each containing 2 or 3 members; e.g., the number of possible outfits from 3 shirts, 2 shorts and 2 pairs of shoes. VI-H

Benchmarks for Standard VI:

- **Construct charts, tables and graphs to represent data, including line graphs, line plots and Venn diagrams.**
- **Read, interpret and construct graphs in which icons represent more than a single unit or intervals greater than one; e.g., each Δ = 10 bikes or the intervals on an axis are multiples of ten.**
- **Conduct a simple probability experiment and draw conclusions about the likelihood of possible outcomes.**
- **Identify and represent possible outcomes, such as arrangements of a set of up to four members and possible combinations from several sets, each containing 2 or 3 members.**
- **Use the set of possible outcomes to describe and predict events.**

Key to using this document:

- **Items in bold with Roman numerals are COS standards.**
- **Items in bold without Roman numerals are benchmarks.**
- Items in regular print are state grade level indicators with the COS letter/number correlation.
- *Items in italics reference the Diocesan COS objectives that are not in state standards.*

Grade 5 - Mathematics

Standards I: Mathematical Processes.

- A. Use a variety of tools and strategies in problem solving. I-A
- B. Apply mathematical knowledge and skills routinely in other content areas and practical situations. I-B
- C. Recognize and use connections between equivalent representations and related procedures. I-C
- D. Evaluate the reasonableness of predictions, estimations and solutions. I-D
- E. Use a variety of mathematical representations to organize, record, and communicate mathematical ideas. I-E
- F. Use mathematical language and symbols to explain, analyze, and justify mathematical ideas, strategies, and solutions. I-F
- G. Write clearly and coherently about mathematical thinking and ideas. I-G

Benchmarks for Standard I:

- **Recognize whether an estimate or an exact solution is appropriate for a given problem situation.**
- **Recognize basic valid and invalid arguments, and use examples and counter examples, models, number relationships, and logic to support or refute.**
- **Communicate mathematical thinking to others and analyze the mathematical thinking and strategies of others.**
- **Recognize and use mathematical language and symbols when reading, writing and conversing with others.**
- **Use mathematical language to explain and justify mathematical ideas, strategies and solutions.**

Standards II: Number, Number Sense and Operations.

- A. Use models and visual representation to develop the concept of ratio as part-to-part and part-to-whole, and the concept of percent as part-to-whole, including percents greater than 100 and less than one. II-A, I-E

- B. Use various forms of "one" to demonstrate the equivalence of fractions;
e.g., $\frac{18}{24} = \frac{9}{12} \times \frac{2}{2} = \frac{3}{4} \times \frac{6}{6}$. II-C
- C. Identify and generate equivalent forms of fractions, decimals and percents. II-C
- D. Round decimals to a given place value and round fractions (including mixed numbers) to the nearest half. II-D
- E. Read, write, represent and compare decimals. II-C
- F. Recognize and identify perfect squares and their roots. II-A,B
- G. Represent and compare numbers less than 0 by extending the number line and using familiar applications; e.g., temperature, owing money. II-B,C
- H. Use commutative, associative, distributive, identity and inverse properties to simplify and perform computations. II-B,D
- I. Identify and use relationships between operations to solve problems. II-B
- J. Explain why fractions need common denominators to be added or subtracted. II-B
- K. Compare, describe and order fractions. II-B
- L. Explain how place value is related to addition and subtraction of decimals; e.g., $0.2 + 0.14$; the two tenths is added to the one tenth because they are both tenths. II-B
- M. Use physical models, points of reference, and equivalent forms to add and subtract commonly used fractions with like and unlike denominators and decimals. II-A, I-E
- N. Estimate the results of computations involving whole numbers, fractions and decimals, using a variety of strategies. II-D
- O. Identify and represent factors and multiples of whole numbers through 100, and classify numbers as prime or composite. II-B
- P. *Demonstrate fluency in using multiplication and division facts in basic computation and problem solving.* II-B,D
- Q. Demonstrate fluency in multiplying and dividing whole numbers by one and two digit numbers and multiples of ten. II-B,D

Benchmarks for Standard II:

- **Represent and compare numbers less than 0 through familiar applications and extending the number line.**
- **Use place value structure of the base-ten number system to read, write, represent and compare decimals.**
- **Recognize and generate equivalent representations for whole numbers, fractions and decimals.**
- **Use models, points of reference and equivalent forms of commonly used fractions to judge the size of fractions and to compare, describe and order them.**
- **Add and subtract fractions with like and unlike denominators.**
- **Recognize and classify numbers as prime or composite and list factors.**

Standard III: Measurement.

- A. Identify and select appropriate units to measure angles; i.e., degrees. III-A,B
- B. Identify paths between points on a grid or coordinate plane and compare the lengths of the paths; e.g., shortest path, paths of equal length. III-C
- C. Demonstrate and describe the differences between covering the faces (surface area) and filling the interior (volume) of three-dimensional objects III-C
- D. Demonstrate understanding of the differences among linear units, square units and cubic units. III-B
- E. Make conversions within the same measurement system while performing computations. III-E
- F. Use strategies to develop formulas for determining perimeter and area of triangles, rectangles and parallelograms, and volume of rectangular prisms. III-C, I-A
- G. Use benchmark angles (e.g.; 45° , 90° , 120°) to estimate the measure of angles, and use a tool to measure and draw angles. III-A,B,C

Benchmark for Standard III:

- **Identify and draw right, obtuse, acute and straight angles.**

Standard IV: Geometry and Spatial Sense.

- A. Draw circles, and identify and determine relationships among the radius, diameter, center and circumference; e.g., radius is half the diameter, the ratio of the circumference of a circle to its diameter is an approximation of π . IV- A,E,G
- B. Use standard language to describe line, segment, ray, angle, skew, parallel and perpendicular. IV-C,D,G
- C. Label vertex, rays, interior and exterior for an angle. IV-D,G
- D. Describe and use properties of congruent figures to solve problems. IV-I
- E. Understand that the measure of an angle is determined by the degree of rotation of an angle side rather than the length of either side. IV-D
- F. Predict what three-dimensional object will result from folding a two-dimensional net, then confirm the prediction by folding the net. IV-E
- G. Identify, describe and use reflections (flips), rotations (turns), and translations (slides) in solving geometric problems; e.g., use transformations to determine if 2 shapes are congruent. IV-F

Benchmarks for Standard IV:

- **Identify and label angle parts and the regions defined within the plane where the angle resides.**
- **Describe, identify and model reflections, rotations and translations, using physical materials.**
- **Describe a series of transformations that show shapes are congruent.**

Standard V: Patterns, Functions and Algebra.

- A. Explain a general rule for a pattern or a function using physical materials, visual representations, words, tables or graphs. V-G, I-E
- B. Use calculators or computers to develop patterns, and generalize them using tables and graphs. V-C
- C. Use variables as unknown quantities in general rules when describing patterns and other relationships. V-G
- D. Create and interpret the meaning of equations and inequalities representing problem situations. V-J

- E. Model problems with physical materials and visual representations, and use models, graphs and tables to draw conclusions and make predictions. V-H, I-E
- F. Describe how the quantitative change in a variable affects the value of a related variable; e.g., describe how the rate of growth varies over time, based upon data in a table or graph. V-K
- G. Construct a table of values to solve problems associated with a mathematical relationships. V-D

Benchmark for Standard V:

- **Construct and use a table of values to solve problems associated with mathematical relationships.**
- **Describe how a change in one variable affects the value of a related variable.**

Standard VI: Data Analysis and Probability.

- A. Read, construct and interpret frequency tables, circle graphs and line graphs. VI-B
- B. Select and use a graph that is appropriate for the type of data to be displayed; e.g., numerical vs. categorical data, discrete vs. continuous data. VI-B
- C. Read and interpret increasingly complex displays of data, such as double bar graphs. VI-B
- D. Determine appropriate data to be collected to answer questions posed by students or teacher, collect and display data, and clearly communicate findings. VI-A
- E. Modify initial conclusions, propose and justify new interpretations and predictions as additional data are collected. VI-D
- F. Describe the characteristics of a set of data based on a graphical representation, such as range of the data, clumps of data, and holes in the data. VI-C
- G. Determine and use the range, mean, median and mode, and explain what each does and does not indicate about the set of data. VI-C
- H. Use the range, mean and median to make comparisons among related sets of data. VI-C
- I. List and explain all possible outcomes in a given situation. VI-F
- J. Identify the probability of events within a simple experiment, such as three chances out of eight. VI-G

- K. Use 0, 1 and ratios between 0 and 1 to represent the probability of outcomes for an event, and associate the ratio with the likelihood of the outcome (impossible, unlikely, equal, likely, certain). VI-H
- L. Compare what should happen (theoretical/expected results) with what did happen (experimental/actual results) in a simple experiment. VI-C,D,F
- M. Make predictions based on experimental and theoretical probabilities. VI-F

Benchmarks for Standard VI:

- **Interpret data by looking for patterns and relationships, draw and justify conclusions, and answer related questions.**
- **Collect, organize, display and interpret data for a specific purpose or need.**
- **Find all possible outcomes of simple experiments or problem situations, using methods such as lists, arrays, and tree diagrams.**
- **Compare experimental and theoretical results for a variety of simple experiments.**
- **Describe data using mode, median and range.**

Key to using this document:

- **Items in bold with Roman numerals are COS standards.**
- **Items in bold without Roman numerals are benchmarks.**
- Items in regular print are state grade level indicators with the COS letter/number correlation.
- *Items in italics are in the diocesan course of study, not in state standards.*

Grade 6 - Mathematics

Standards I: Mathematical Processes.

- A. Use a variety of tools and strategies in problem solving. I-A
- B. Apply mathematical knowledge and skills routinely in other content areas and practical situations. I-B
- C. Recognize and use connections between equivalent representations and related procedures. I-C
- D. Evaluate the reasonableness of predictions, estimations and solutions. I-D
- E. Use a variety of mathematical representations to organize, record, and communicate mathematical ideas. I-E
- F. Use mathematical language and symbols to explain, analyze, and justify mathematical ideas, strategies, and solutions. I-F
- G. Write clearly and coherently about mathematical thinking and ideas. I-G

Benchmarks for Standard I:

- Clarify problem-solving situations and identify potential solution processes; e.g., consider different strategies and approaches to a problem, restate problem from various perspectives.
- Use representations to organize and communicate mathematical thinking and problem solutions.
- Communicate mathematical thinking to others and analyze the mathematical thinking and strategies of others.
- Recognize and use mathematical language and symbols when reading, writing and conversing with others.

Standards II: Number, Number Sense and Operations.

- A. Decompose and recompose whole numbers using factors and exponents (e.g., $32 = 2 \times 2 \times 2 \times 2 \times 2 = 2^5$), and explain why "squared" means "second power" and "cubed" means "third power." II-C

- B. Find and use the prime factorization of composite numbers. For example: II-C
 1. Use the prime factorization to recognize the greatest common factor (GCF).
 2. Use the prime factorization to recognize the least common multiple (LCM).
 3. Apply the prime factorization to solve problems and explain solutions.
- C. Explain why a number is referred to as being "rational," and recognize that the expression $\frac{a}{b}$ can mean a parts of size $\frac{1}{b}$ each, a divided by b, or the ratio of a to b. II-A
- D. Describe what it means to find a specific percent of a number, using real-life examples. II-A
- E. Use models and pictures to relate concepts of ratio, proportion and percent, including percents less than 1 and greater than 100. II-A, I-E
- F. Use the order of operations, including the use of parentheses, exponents, decimals and rational numbers, to simplify numerical expressions. II-B
- G. Use simple expressions involving integers to represent and solve problems; e.g., if a running back loses 15 yards on the first carry but gains 8 yards on the second carry, what is the net gain/loss? II-A
- H. Represent multiplication and division situations involving fractions and decimals with models and visual representations; e.g., show with pattern blocks what it means to take $2\frac{2}{3} \div \frac{1}{6}$. II-A, I-E
 - I. Give examples of how ratios are used to represent comparisons; e.g., part-to-part, part-to-whole, whole-to-part. II-C
 - J. Recognize that a quotient may be larger than the dividend when the divisor is a fraction; e.g., $6 \div \frac{1}{2} = 12$. II-B
- K. Perform fraction and decimal computations and justify their solutions; e.g., using manipulatives, diagrams, mathematical reasoning. II-B
- L. Develop and analyze algorithms for computing with fractions and decimals, and demonstrate fluency in their use. II-D

- M. Estimate reasonable solutions to problem situations involving fractions and decimals; e.g., $\frac{7}{8} + \frac{12}{13} \approx 2$ and $4.23 \times 5.8 \approx 25$. II-D
- N. Use proportional reasoning, ratios and percents to represent problem situations and determine the reasonableness of solutions. II-C
- O. Compare, order and convert fractions, decimals and percents. II-C

Benchmarks for Standard II:

- Compare, order and convert among fractions, decimals and percents.
- Demonstrate an understanding of percents, including percents greater than 100 and less than 1.
- Apply and explain the use of prime factorization, common factors and common multiples in problem situations.
- Perform operations (addition, subtraction, multiplication and division) with fractions and mixed numbers with like and unlike denominators.

Standard III: Measurement.

- A. Understand and describe the difference between surface area and volume. III-D
- B. Use strategies to develop formulas for finding circumference and area of circles, and to determine the area of sectors; e.g., 1/2 circle, 2/3 circle, 1/3 circle and 1/4 circle. III-D
- C. Estimate perimeter or circumference and area for circles, triangles and quadrilaterals, and surface area and volume for prisms and cylinders by: III-C
 1. estimating lengths using string or links, areas using tiles or grid, and volumes using cubes;
 2. measuring attributes (diameter, side lengths, or heights) and using established formulas for circles, triangles, rectangles, parallelograms and rectangular prisms.
- D. Determine which measure (perimeter, area, surface area, volume) matches the context for a problem situation; e.g., perimeter is the context for fencing a garden, surface area is the context for painting a room. III-B

- E. Understand the difference between perimeter and area, and demonstrate that two shapes may have the same perimeter, but different areas or may have the same area, but different perimeters. III-D
- F. 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. III-D.
- G. Use formulas to solve perimeter, area and circumference of triangles, circles and quadrilaterals. III-C

Benchmarks for Standard III:

- **Select a tool and measure accurately to a specified level of precision.**
- **Convert units of length, mass and time within the same measurement system.**
- **Identify appropriate formulas and apply appropriate techniques for measuring angles, perimeter and area of triangles circles, and quadrilaterals.**
- **Understand and demonstrate the independence of perimeter and area for two-dimensional shapes.**
- **Analyze and explain what happens to area and perimeter when the dimensions of an object are changed.**

Standard IV: Geometry and Spatial Sense.

- A. Use physical models to determine the sum of the interior angles of triangles and quadrilaterals. IV-D, I-E
- B. Classify and 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. IV-A
- C. Use standard language to define geometric vocabulary: vertex, face, altitude, diagonal, isosceles, equilateral, acute, obtuse and other vocabulary as appropriate. IV-G
- D. Use multiple classification criteria to classify triangles; e.g., right scalene triangle. IV-A
- E. Identify and define relationships between planes; i.e., parallel, perpendicular and intersecting. IV-A

- F. Predict and describe sizes, positions and orientations of two-dimensional shapes after transformations such as reflections, rotations, translations and dilations. IV-F
- G. Draw similar figures that model proportional relationships; e.g., model similar figures with a 1 to 2 relationship by sketching two of the same figure, one with corresponding sides twice the length of the other. IV-E
- H. Build three-dimensional objects with cubes, and sketch the two-dimensional representations of each side; i.e., projection sets. IV-E
- I. Extend understanding of coordinate system to include points whose x or y values may be negative numbers. IV-B
- J. Draw circles and identify and determine the relationships among radius, diameter, center and circumference. IV-A

Benchmarks for Standard IV:

- **Draw circles, and identify and determine the relationships among radius, diameter, center and circumference.**
- **Predict and describe results (size, position, orientation) of transformations of two-dimensional figures.**

Standard V: Patterns, Functions and Algebra.

- A. Represent and analyze patterns, rules and functions, using physical materials, tables and graphs. V-D
- B. Use words and symbols to describe numerical and geometric patterns, rules and functions. V-G
- C. Recognize and generate equivalent forms of algebraic expressions, and explain how the commutative, associative and distributive properties can be used to generate equivalent forms; e.g., perimeter as $2(l + w)$ or $2l + 2w$. V-I
- D. Solve simple linear equations and inequalities using physical models, paper and pencil, tables and graphs. V-J
- E. Produce and interpret graphs that represent the relationship between two variables. V-D
- F. Evaluate simple expressions by replacing variables with given values, and use formulas in problem-solving situations. V-I,L

- G. Identify and describe situations with constant or varying rates of change, and compare them. V-K
- H. Use technology to analyze change; e.g., use computer applications or graphing calculators to display and interpret rate of change. V-K

Benchmarks for Standard V:

- **Represent, analyze and generalize a variety of patterns and functions with tables, graphs, words and symbolic rules.**
- **Use symbolic algebra to represent and explain mathematical relationships.**
- **Use formulas in problem-solving situations.**

Standard VI: Data Analysis and Probability.

- A. Read, construct and interpret line graphs, circle graphs and histograms. VI-B
- B. Select, create and use graphical representations that are appropriate for the type of data collected. VI-B
- C. Compare representations of the same data in different types of graphs, such as a bar graph and circle graph. VI-C
- D. Understand the different information provided by measures of center (mean, mode and median) and measures of spread (range). VI-C
- E. Describe the frequency distribution of a set of data, as shown in a histogram or frequency table, by general appearance or shape; e.g., number of modes, middle of data, level of symmetry, outliers. VI-B
- F. Make logical inferences from statistical data. VI-F
- G. Design an experiment to test a theoretical probability and explain how the results may vary. VI-G

Benchmarks for Standard VI:

- **Read, create and use line graphs and histograms.**
- **Evaluate interpretations and conclusions as additional data are collected, modify conclusions and predictions, and justify new findings.**
- **Determine and use the range, mean, median and mode to analyze and compare data, and explain what each indicates about the data.**

- Describe the probability of an event using ratios, including fractional notation.
- Make and justify predications based on experimental and theoretical probabilities.

Key to using this document:

- **Items in bold with Roman numerals are COS standards.**

- **Items in bold without Roman numerals are benchmarks.**

- Items in regular print are state grade level indicators with the COS letter/number correlation.

- *Items in italics are in the diocesan course of study, not state standards.*

Grade 7 - Mathematics

Standards I: Mathematical Processes.

- A. *Use a variety of tools and strategies in problem solving. I-A*
- B. *Apply mathematical knowledge and skills routinely in other content areas and practical situations. I-B*
- C. *Recognize and use connections between equivalent representations and related procedures. I-C*
- D. *Evaluate the reasonableness of predictions, estimations and solutions. I-D*
- E. *Use a variety of mathematical representations to organize, record, and communicate mathematical ideas. I-E*
- F. *Use mathematical language and symbols to explain, analyze, and justify mathematical ideas, strategies, and solutions. I-F*
- G. *Write clearly and coherently about mathematical thinking and ideas. I-G*

Benchmarks for Standard I:

- **Use inductive thinking to generalize a pattern of observations for particular cases, make conjectures, and provide supporting arguments for conjectures.**
- **Relate mathematical ideas to one another and to other content areas; e.g., use models for adding fractions, interpret graphs in reading, science and social studies.**
- **Select, apply, and translate among mathematical representations to solve problems; e.g., representing a number as a fraction, decimal or percent as appropriate for a problem.**
- **Communicate mathematical thinking to others and analyze the mathematical thinking and strategies of others.**
- **Recognize and use mathematical language and symbols when reading, writing and conversing with others.**
- **Apply and adapt problem-solving strategies to solve a variety of problems, including unfamiliar and non-routine problem situations.**

- **Use more than one strategy to solve a problem, and recognize there are advantages associated with various methods.**

Standards II: Number, Number Sense and Operations.

- A. Demonstrate an understanding of place value using powers of 10. II-
- B. Write large numbers in scientific notation. II-C
- C. Continue the use of prime factorization. II-C
- D. Explain the meaning of exponents that are negative or 0. II-B
- E. Describe differences between rational and irrational numbers; e.g., use technology to show that some numbers (rational) can be expressed as terminating or repeating decimals and others (irrational) as non-terminating and non-repeating decimals. II-C
- F. Use order of operations and properties to simplify numerical expressions involving integers, fractions and integers.
- G. Explain the meaning and effect of adding, subtracting, multiplying and dividing integers; e.g., how adding two integers can result in a lesser value. II-B
- H. Simplify numerical expressions involving integers and use integers to solve real-life problems. II-B
 - I. Solve problems using the appropriate form of a rational number (fraction, decimal or percent). II-C
 - J. Represent and solve problem situations that can be modeled by and solved using concepts of absolute value, exponents and square roots (for perfect squares). II-A
 - K. Determine the percent of a number and solve related problems; e.g. find the percent markdown if the original price was \$140, and the sale price is \$100. II-B

Benchmarks for Standard II:

- **Use models and pictures to relate concepts of ratio, proportion and percent.**

- **Use order of operations, including use of parenthesis and exponents to solve multi-step problems, and verify and interpret the results.**
- **Apply number system properties when performing computations.**
- **Use a variety of strategies, including proportional reasoning, to estimate, compute, solve and explain solutions to problems involving integers, fractions, decimals and percents.**
- **Relate mathematical ideas to one another and to other content areas; e.g. use area models for adding fractions interpret graphs in reading, science and social studies.**

Standard III: Measurement Standard

- A. Select appropriate units for measuring derived measurements; e.g., miles per hour, revolutions per minute. III-B
- B. 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. III-E
- C. Estimate a measurement to a greater degree of precision than the tool provides. III-C
- D. Solve problems involving proportional relationships and scale factors; e.g., scale models that require unit conversions within the same measurement system. III-C
- E. Analyze problem situations involving measurement concepts, select appropriate strategies, and use an organized approach to solve narrative and increasingly complex problems. III-C
- F. Use strategies to develop formulas for finding area of trapezoids and volume of cylinders and prisms. III-C
- G. Develop strategies to find the area of composite shapes using the areas of triangles, parallelograms, circles and sectors. III-C

- H. Understand the difference between surface area and volume and demonstrate that two objects may have the same surface area, but different volumes or may have the same volume, but different surface areas. III-D
- I. Describe what happens to the surface area and volume of a three-dimensional object when the measurements of the object are changed; e.g., length of sides are doubled. III-C

Benchmarks for Standard III:

- **Select appropriate tools and units to measure angles, circumference, surface area, mass and volume using: U.S. customary units; e.g. degrees, square feet, pounds and other units as appropriate; metric units; e.g. square meters, kilograms and other units as appropriate.**
- **Convert units of length, area, volume, mass and time within the same measurement systems.**
- **Identify appropriate formula and apply appropriate techniques for measuring composite shapes and surface area and volume of prisms and cylinders.**
- **Understand and demonstrate the independence of surface area and volume for three-dimensional shapes.**
- **Use problem solving techniques and technology as needed to solve problems involving length, weight, perimeter, area, volume, time and temperature.**
- **Analyze and explain what happens to surface area and volume when the dimensions of an object are changed.**

Standard IV: Geometry and Spatial Sense.

- A. Use proportional reasoning to describe and express relationships between parts and attributes of similar and congruent figures. IV-A
- B. Determine sufficient (not necessarily minimal) properties that define a specific two-dimensional figure or three-dimensional object. For example: IV-A
1. Determine when one set of figures is a subset of another; e.g., all squares are rectangles.

2. Develop a set of properties that eliminates all but the desired figure; e.g., only squares are quadrilaterals with all sides congruent and all angles congruent.
- C. Use and demonstrate understanding of the properties of triangles. For example: IV-A
1. Use Pythagorean Theorem to solve problems involving right triangles.
 2. Use triangle angle sum relationships to solve problems.
- D. Determine necessary conditions for congruence of triangles. IV-A
- E. Apply properties of congruent or similar triangles to solve problems involving missing lengths and angle measures. IV-I
- F. Determine and use scale factors for similar figures to solve problems using proportional reasoning. IV-I
- G. Identify the line and rotation symmetries of two-dimensional figures to solve problems. IV-I
- H. Perform translations, reflections, rotations and dilations of two-dimensional figures using a variety of methods (paper folding, tracing, graph paper). IV-F
1. Draw representations of three-dimensional geometric objects from different views. IV-E

Benchmarks for Standard IV:

- **Specify locations and plot ordered pairs on a coordinate plane.**
- **Identify, describe and classify types of line pairs, angles, two-dimensional figures and three-dimensional objects using their properties.**
- **Use proportions to express relationships among corresponding parts of similar figures.**
- **Describe and use the concepts of congruence, similarity and symmetry to solve problems.**
- **Identify and draw three-dimensional objects from different views (top, side, front and perspective).**
- **Apply properties of equality and proportionality to solve problems involving congruent or similar figures; e.g., create a scale drawing.**

- **Describe and use properties of triangles to solve problems involving angle measurement and side lengths of right triangles.**

Standard V: Patterns, Functions and Algebra.

- A. Represent and analyze patterns, rules and functions with words, tables, graphs and simple variable expressions. V-D
- B. Generalize patterns by describing in words how to find the next term. V-B
- C. Recognize and explain when numerical patterns are linear or nonlinear progressions; e.g., 1, 3, 5, 7... is linear and 1, 3, 4, 8, 16... is nonlinear. V-B
- D. Create visual representations of equation-solving processes that model the use of inverse operations. V-H, I-E
- E. Represent linear equations by plotting points in the coordinate plane. V-D
- F. Represent inequalities on a number line or a coordinate plane. V-D
- G. 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 $a \cdot 5 + 4 = 5a + 4$. V-I
- H. Use formulas in problem-solving situations. V-L
1. Recognize a variety of uses for variables; e.g., placeholder for an unknown quantity in an equation, generalization for a pattern, formula. V-G
- J. Analyze linear and simple nonlinear relationships to explain how a change in one variable results in the change of another. V-K

Benchmarks for Standard V:

- **Describe, extend and determine the rule for patterns and relationships occurring in numeric patterns, computation, geometry, graphs and other applications.**
- **Use variables to create and solve equations and inequalities representing problem situations.**
- **Use representations, such as tables, graphs and equations, to model situations and to solve problems.**
- **Write, simplify and evaluate algebraic expressions.**
- **Solve linear equations and inequalities symbolically and numerically.**

- Explain how inverse operations are used to solve linear equations.
- Graph linear equations and inequalities on a number line.

Standard VI: Data Analysis and Probability.

- Read, create and interpret box-and-whisker plots, stem-and-leaf plots, and other types of graphs, when appropriate. VI-B
- 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. VI-C
- Analyze a set of data by using and comparing combinations of measures of center (mean, mode, median) and measures of spread (range, quartile, interquartile range), and describe how the inclusion or exclusion of outliers affects those measures. VI-C
- Construct opposing arguments based on analysis of the same data, using different graphical representations. VI-D
- Compare data from two or more samples to determine how sample selection can influence results. VI-C
- Identify misuses of statistical data in articles, advertisements, and other media. VI-I
- Identify different ways of selecting samples, such as survey response, random sample, representative sample and convenience sample. VI-E
- Describe how the relative size of a sample compared to the target population affects the validity of predictions. VI-I
 - Compute probabilities of compound events; e.g., multiple coin tosses or multiple rolls of number cubes, using such methods as organized lists, tree diagrams and area models. VI-H
- Make predictions based on theoretical probabilities, design and conduct an experiment to test the predictions, compare actual results to predicted results, and explain differences. VI-G

Benchmarks for Standard VI:

- Read, create and use circle graphs, box-and-whisker plots, stem-and-leaf plots, and other representations when appropriate.

- Compare increasingly complex displays of data such as multiple sets of data on the same graph.
- Evaluate conjectures and predictions based upon data presented in tables and graphs, and identify misuses of statistical data and displays.
- Make and justify predictions based on experimental and theoretical probabilities.
- Evaluate the validity of claims and predictions that are based on data by examining the appropriateness of the data collection and analysis.
- Describe sampling methods and analyze the effects of method chosen on how well the resulting sample represents the population.

Key to using this document:

- Items in bold with Roman numerals are COS standards.

- Items in bold without Roman numerals are benchmarks.

- Items in regular print are state grade level indicators with the COS letter/number correlation.

- Items in italics are in the diocesan course of study, not in state standards.

Grade 8 - Mathematics

Standards I: Mathematical Processes.

- A. *Use a variety of tools and strategies in problem solving. I-A*
- B. *Apply mathematical knowledge and skills routinely in other content areas and practical situations. I-B*
- C. *Recognize and use connections between equivalent representations and related procedures. I-C*
- D. *Evaluate the reasonableness of predictions, estimations and solutions. I-D*
- E. *Use a variety of mathematical representations to organize, record, and communicate mathematical ideas. I-E*
- F. *Use mathematical language and symbols to explain, analyze, and justify mathematical ideas, strategies, and solutions. I-F*
- G. *Write clearly and coherently about mathematical thinking and ideas. I-G*

Benchmarks for Standard I:

- **Formulate a problem or mathematical model in response to a specific need or situation, determine information required to solve the problem, choose method for obtaining this information, and set limits for acceptable solution.**
- **Apply mathematical knowledge and skills routinely in other content areas and practical situations.**
- **Use a variety of mathematical representations flexibly and appropriately to organize, record and communicate mathematical ideas.**
- **Use precise mathematical language and notations to represent problem situations and mathematical ideas.**
- **Write clearly and coherently about mathematical thinking and ideas.**
- **Communicate mathematical thinking to others and analyze the mathematical thinking and strategies of others.**
- **Locate and interpret mathematical information accurately, and communicate ideas, processes and**

solutions in a complete and easily understood manner.

- **Use deductive thinking to construct informal arguments to support reasoning and to justify solutions to problems.**

Standards II: Number, Number Sense and Operations.

- A. Use scientific notation to express large numbers and small numbers between 0 and 1. II-C
- B. Recognize that natural numbers, whole numbers, integers, rational numbers and irrational numbers are subsets of the real number system. II-C
- C. Apply order of operations to simplify expressions and perform computations involving integers, both positive and negative, exponents and radicals. II-B
- D. Explain and use the inverse and identity properties and use inverse relationships (addition/subtraction, multiplication/division, squaring/square roots) in problem solving situations. II-B
- E. Determine when an estimate is sufficient and when an exact answer is needed in problem situations, and evaluate estimates in relation to actual answers; e.g., very close, less than, greater than. II-D
- F. Estimate, compute and solve problems involving rational numbers, including ratio, proportion and percent, and judge the reasonableness of solutions. II-D
- G. Find the square root of perfect squares, and approximate the square root of non-perfect squares as consecutive integers between which the root lies; e.g., $\sqrt{130}$ is between 11 and 12. II-C
- H. Add, subtract, multiply, divide and compare numbers written in scientific notation. II-B
- I. Develop and analyze algorithms for computing with percents and integers and demonstrate fluency in their use. II-D

Benchmarks for Standard II:

- **Use scientific notation to express large numbers and numbers less than one.**
- **Apply properties of operations and the real number system, and justify when they hold for a set of numbers.**
- **Connect physical, verbal and symbolic representations of integers, rational numbers and irrational numbers.**
- **Compare, order and determine equivalent forms of real numbers.**
- **Find the square root of perfect squares, and approximate the square root of non-perfect squares.**
- **Compute and solve problems involving percents.**
- **Compute with integers.**
- **Use and analyze the steps in standard and non-standard algorithm for computing with fractions, decimals and percents.**

Standard III: Measurement.

- A. Compare and order the relative size of common U.S. customary units and metric units; e.g., mile and kilometer, gallon and liter, pound and kilogram. III-B
- B. Use proportional relationships and formulas to convert units from one measurement system to another; e.g., degrees Fahrenheit to degrees Celsius. III-C
- C. Use appropriate levels of precision when calculating with measurements. III-A
- D. Derive formulas for surface area and volume and justify them using geometric models and common materials. For example, find: III-C
 1. the surface area of a cylinder as a function of its height and radius;
 2. 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.
- E. Determine the surface area for pyramids by analyzing their parts. III-C

- F. Solve and determine the reasonableness of the results for problems involving rates and derived measurements, such as velocity and density, using formulas, models and graphs. III-C
- G. Apply proportional reasoning to solve problems involving indirect measurements or rates. III-C
- H. Find the sum of the interior and exterior angles of regular convex polygons with and without measuring the angles with a protractor. III-C
- I. Demonstrate understanding of the concepts of perimeter, circumference and area by using established formulas for triangles, quadrilaterals, and circles to determine the surface area and volume of prisms, pyramids, cylinders, spheres and cones. (Note: Only volume should be calculated for spheres and cones.) III-C
- J. Use conventional formulas to find the surface area and volume of prisms, pyramids and cylinders and the volume of spheres and cones to a specified level of precision. III-C

Benchmarks for Standard III:

- **Use formulas to find surface area and volume for specified three-dimensional objects accurate to a specified level of precision.**
- **Apply indirect measurement techniques, tools and formulas, as appropriate, to find perimeter, circumference and area of circles, triangles, quadrilaterals and composite shapes, and to find volume of prisms, cylinders, and pyramids.**
- **Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.**
- **Write and solve real-world problems involving money, elapsed time and temperature, and verify reasonableness of solution.**

Standard IV: Geometry and Spatial Sense.

- A. Make and test conjectures about characteristics and properties (e.g., sides, angles, symmetry) of two-dimensional figures and three-dimensional objects. IV-A

- B. Recognize the angles formed and the relationship between the angles when two lines intersect and when parallel lines are cut by a transversal. IV-B
- C. Use proportions in several forms to solve problems involving similar figures (part-to-part, part-to-whole, corresponding sides between figures). IV-I
- D. Represent and analyze shapes using coordinate geometry; e.g., given three vertices and the type of quadrilateral, find the coordinates of the fourth vertex. IV-B
- E. Draw the results of translations, reflections, rotations and dilations of objects in the coordinate plane, and determine properties that remain fixed; e.g., lengths of sides remain the same under translations. IV-B
- F. Draw nets for a variety of prisms, pyramids, cylinders and cones. IV-E
- G. Describe and use properties of triangles to solve problems involving angle measures and side lengths of a right triangle.

Benchmark for Standard IV:

- **Recognize and apply angle relationships in situations involving intersecting lines, perpendicular lines and parallel lines.**
- **Represent and model transformations in a coordinate plane and describe the results.**

Standard V: Patterns, Functions and Algebra.

- A. Relate the various representations of a relationship; i.e., relate a table to graph, description and symbolic form. V-D
- B. Generalize patterns and sequences by describing how to find the nth term. V-B
- C. Identify functions as linear or nonlinear based on information given in a table, graph or equation. V-K
- D. Extend the uses of variables to include covariants where y depends on x. V-K
- E. Use physical models to add and subtract monomials and polynomials, and to multiply a polynomial by a monomial. V-F

- F. Describe the relationship between the graph of a line and its equation, including being able to explain the meaning of slope as a constant rate of change and y-intercept in real-world problems. V-K
- G. Use symbolic algebra (equations and inequalities), graphs and tables to represent situations and solve problems. V-H
- H. Write, simplify and evaluate algebraic expressions (including formulas) to generalize situations and solve problems. V-I
 - I. Solve linear equations and inequalities graphically, symbolically and using technology. V-I,J
 - J. Interpret the meaning of the solution of a 2 by 2 system of equations; i.e., point, line, no solution. V-J
- K. Solve 2 by 2 systems of linear equations graphically and by simple substitution. V-J
- L. Solve simple quadratic equations graphically; e.g., $y = x^2 - 16$. V-J
- M. Compute and interpret slope, midpoint and distance given a set of ordered pairs. V-L
- N. Differentiate and explain types of changes in mathematical relationships, such as linear vs. nonlinear, continuous vs. noncontinuous, direct variation vs. inverse variation. V-K
- O. Describe and compare how changes in an equation affects the related graphs; e.g., for a linear equation changing the coefficient of x affects the slope and changing the constant affects the intercepts. V-K
- P. Use graphing calculators or computers to analyze change; e.g., interest compounded over time as a nonlinear growth pattern. V-K

Benchmark for Standard V:

- **Analyze functional relationships and explain how a change in one quantity results in a change in another.**
- **Solve linear equations and inequalities symbolically, graphically and numerically.**
- **Use rules and variables to describe patterns, functions and other relationships.**

- Use representations such as tables, graphs and equations to model situations and to solve problems, especially those that involve linear relationships.
- Graph linear equations and inequalities using a coordinate plane.
- Approximate and interpret rates of change from graphical and numerical data.

Standard VI: Data Analysis and Probability.

- A. Use, create and interpret scatterplots and other types of graphs as appropriate. VI-B
- B. Evaluate different graphical representations of the same data to determine which is the most appropriate representation for an identified purpose; e.g., line graph for change over time, circle graph for part-to-whole comparison, scatterplot for relationship between two variants. VI-C
- C. Continue to use circle graphs, histograms, box-and-whisker plots, stem-and leaf plots. VI-B
- D. Differentiate between discrete and continuous data and appropriate ways to represent each. VI-D
- E. Compare two sets of data using measures of center (mean, mode, median) and measures of spread (range, quartiles, interquartile range, percentiles). VI-C
- F. Explain the mean's sensitivity to extremes and its use in comparison with the median and mode. VI-C
- G. Make conjectures about possible relationship in a scatterplot and approximate line of best fit. VI-D
- H. Construct convincing arguments based on analysis of data and interpretation of graphs. VI-D
- I. Calculate the number of possible outcomes for a situation, recognizing and accounting for when items may occur more than once or when order is important. VI-H
- J. Compute probabilities of compound events, independent events, and simple dependent events. VI-H

Benchmarks for Standard VI:

- **Read, create and use line graphs, histograms, circle graphs, box-and-whisker plots, stem-and-leaf plot.**

- **Construct convincing arguments of analysis of data and interpretation of graphs.**
- **Compare the characteristics of the mean, median and mode for a given set of data and explain which measure of center best represents the data.**
- **Find, use and interpret measures of center and spread, such as mean and quartiles and use those measures to compare and draw conclusions about sets of data.**

Key to using this document:

- **Items in bold with Roman numerals are COS standards.**

- **Items in bold without Roman numerals are benchmarks.**

- Items in regular print are state grade level indicators with the COS letter/number correlation.

- *Items in italics are in the diocesan course of study, not in state standards.*

Grade 9 - Mathematics

Standards I: Mathematical Processes.

- A. *Use a variety of tools and strategies in problem solving. I-A*
- B. *Apply mathematical knowledge and skills routinely in other content areas and practical situations. I-B*
- C. *Recognize and use connections between equivalent representations and related procedures. I-C*
- D. *Evaluate the reasonableness of predictions, estimations and solutions. I-D*
- E. *Use a variety of mathematical representations to organize, record, and communicate mathematical ideas. I-E*
- F. *Use mathematical language and symbols to explain, analyze, and justify mathematical ideas, strategies, and solutions. I-F*
- G. *Write clearly and coherently about mathematical thinking and ideas. I-G*

Benchmarks for Standard I:

- **Formulate a problem or mathematical model in response to a specific need or situation, determine information required to solve the problem, choose method for obtaining this information, and set limits for acceptable solution.**
- **Apply mathematical knowledge and skills routinely in other content areas and practical situations.**
- **Recognize and use connections between equivalent representations and related procedures for a mathematical concept; e.g., zero of a function and the x-intercept of the graph of the function, apply proportional thinking when measuring, describing functions, and comparing probabilities.**
- **Use a variety of mathematical representations to organize, record and communicate mathematical ideas.**
- **Use precise mathematical language and notations to represent problem situations and mathematical ideas.**

- **Write clearly and coherently about mathematical thinking and ideas.**
- **Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.**

Standards II: Number, Number Sense and Operations.

- A. Identify and justify whether properties (closure, identity, inverse, commutative and associative) hold for a given set and operations; e.g., even integers and multiplication. II-B
- B. Compare, order and determine equivalent forms for rational and irrational numbers. II-C
- C. Explain the effects of operations such as multiplication or division, and of computing powers and roots on the magnitude of quantities. II-B
- D. Demonstrate fluency in computations using real numbers. II-B
- E. Estimate the solutions for problem situations involving square and cube roots. II-D

Benchmarks for Standard II:

- **Identify subsets of the real number system.**
- **Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.**
- **Estimate, compute and solve problems involving scientific notation, square roots and numbers with integer exponents.**

Standard III: Measurement.

- A. Convert rates within the same measurement system; e.g., miles per hour to feet per second; kilometers per hour to meters per second.; III-E
- B. Use unit analysis to check computations involving measurement. III-C

- C. Use the ratio of lengths in similar two-dimensional figures or three-dimensional objects to calculate the ratio of their areas or volumes respectively. III-C
- D. Use scale drawings and right triangle trigonometry to solve problems that include unknown distances and angle measures. III-C
- E. Solve problems involving unit conversion for situations involving distances, areas, volumes and rates within the same measurement system. III-E

Standard IV: Geometry and Spatial Sense.

- A. Define the basic trigonometric ratios in right triangles: sine, cosine and tangent. IV-G
- B. Apply proportions and right triangle trigonometric ratios to solve problems involving missing lengths and angle measures in similar figures. IV-I
- C. Analyze two-dimensional figures in a coordinate plane; e.g., use slope and distance formulas to show that a quadrilateral is a parallelogram. IV-I

Standard V: Patterns, Functions and Algebra.

- A. Define function with ordered pairs in which each domain element is assigned exactly one range element. V-A
- B. Generalize patterns using functions or relationships (linear, quadratic and exponential), and freely translate among tabular, graphical and symbolic representations. V-D
- C. Describe problem situations (linear, quadratic and exponential) by using tabular, graphical and symbolic representations. V-D
- D. Demonstrate the relationship among zeros of a function, roots of equations, and solutions of equations graphically and in words. V-J
- E. Describe and compare characteristics of the following families of functions: linear, quadratic and exponential functions; e.g., general shape, number of roots, domain, range, rate of change, maximum or minimum. V-A
- F. Write and use equivalent forms of equations and inequalities in problem situations; e.g., changing a linear equation to the slope-intercept form. V-H
- G. Use formulas to solve problems involving exponential growth and decay. V-L

- H. Find linear equations that represent lines that pass through a given set of ordered pairs, and find linear equations that represent lines parallel or perpendicular to a given line through a specific point. V-G
- I. Solve and interpret the meaning of 2 by 2 systems of linear equations graphically, by substitution and by elimination, with and without technology. V-J
- J. Solve quadratic equations with real roots by factoring, graphing, using the quadratic formula and with technology. V-J
- K. Add, subtract, multiply and divide monomials and polynomials (division of polynomials by monomials only). V-I
- L. Simplify rational expressions by eliminating common factors and applying properties of integer exponents. V-I
- M. Model and solve problems involving direct and inverse variation using proportional reasoning. V-H
- N. Describe the relationship between slope and the graph of a direct variation and inverse variation. V-K
- O. Describe how a change in the value of a constant in a linear or quadratic equation affects the related graphs. V-K

Benchmarks for Standard V:

- **Generalize and explain patterns and sequences in order to find the next term and the nth term.**
- **Identify and classify functions as linear or non-linear, and contrast their properties using tables, graphs and equations.**
- **Translate information from one representation (words, table, graph or equation) to another representation of a relation or a function.**
- **Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.**
- **Analyze and compare functions and their graphs using attributes, such as rates of change, intercepts and zeroes.**
- **Solve and graph linear equations and inequalities.**

- **Solve quadratic equations with real roots by graphing, formula and factoring.**
- **Solve systems of linear equations involving two variables graphically and symbolically.**
- **Model and solve problem situations involving direct and inverse variation.**
- **Describe and interpret rates of change from graphical and numerical data.**

Standard VI: Data Analysis and Probability.

- A. Classify data as univariate (single variable) or bivariate (two variables) and as quantitative (measurement) or qualitative (categorical) data. VI-A
- B. Create a scatterplot for a set of bivariate data, sketch the line of best fit, and interpret the slope of the line of best fit. VI-B
- C. Analyze and interpret frequency distributions based on spread, symmetry, skewness, clusters and outliers. VI-C
- D. Describe and compare various types of studies (survey, observation, experiment), and identify possible misuses of statistical data. VI-C
- E. Describe characteristics and limitations of sampling methods, and analyze the effects of random versus biased sampling; e.g., determine and justify whether the sample is likely to be representative of the population. VI-E
- F. Make inferences about relationships in bivariate data, and recognize the difference between evidence of relationship (correlation) and causation. VI-F
- G. Use counting techniques and the Fundamental Counting principle to determine the total number of possible outcomes for mathematical situations. VI-H
- H. Describe, create and analyze a sample space and use it to calculate probability. VI-G
- I. Identify situations involving independent and dependent events, and explain differences between, and common misconceptions about, probabilities associated with those events. VI-H

- J. Use theoretical and experimental probability, including simulations or random numbers, to estimate probabilities and to solve problems dealing with uncertainty; e.g., compound events, independent events, simple dependent events. VI-H

Benchmarks for Standard VI:

- **Use counting techniques, such as permutations and combinations, to determine the total number of options and possible outcomes.**
- **Design an experiment to test theoretical probability, and record and explain the results.**
- **Compute probabilities of compound events, independent events, and simple dependent events.**
- **Make predictions based on theoretical probabilities and experimental results.**

Key to using this document:

- **Items in bold with Roman numbers are COS standards.**

- **Items in bold without Roman numerals are benchmarks.**

- Items in regular print are state grade level indicators with the COS letter/number correlation.

- *Items in italics are from the diocesan course of study, not in state standards.*

Grade 10 - Mathematics

Standards I: Mathematical Processes.

- A. Use a variety of tools and strategies in problem solving. I-A
- B. Apply mathematical knowledge and skills routinely in other content areas and practical situations. I-B
- C. Recognize and use connections between equivalent representations and related procedures. I-C
- D. Evaluate the reasonableness of predictions, estimations and solutions. I-D
- E. Use a variety of mathematical representations to organize, record, and communicate mathematical ideas. I-E
- F. Use mathematical language and symbols to explain, analyze, and justify mathematical ideas, strategies, and solutions. I-F
- G. Write clearly and coherently about mathematical thinking and ideas. I-G

Benchmarks for Standard I:

- Formulate a problem or mathematical model in response to a specific need or situation, determine information required to solve the problem, choose method for obtaining this information, and set limits for acceptable solution.
- Apply mathematical knowledge and skills routinely in other content areas and practical situations.
- Recognize and use connections between equivalent representations and related procedures for a mathematical concept; e.g., zero of a function and the x-intercept of the graph of the function, apply proportional thinking when measuring, describing functions, and comparing probabilities.
- Apply reasoning processes and skills to construct logical verifications or counter-examples to test conjectures and to justify and defend algorithms and solutions.

- Use a variety of mathematical representations to organize, record and communicate mathematical ideas.
- Use precise mathematical language and notations to represent problem situations and mathematical ideas.
- Write clearly and coherently about mathematical thinking and ideas.
- Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.

Standards II: Number, Number Sense and Operations.

- A. Connect physical, verbal and symbolic representations of irrational numbers; e.g., construct $\sqrt{2}$ as a hypotenuse or on a number line. II-A
- B. Explain the meaning of the nth root. II-B
- C. Use factorial notation and computations to represent and solve problem situations involving arrangements. II-B
- D. Approximate the nth root of a given number greater than zero between consecutive integers when n is an integer; e.g., the 4th root of 50 is between 2 and 3. II-D

Benchmark for Standard II:

- Explain the effects of operations on the magnitude of quantities.

Standard III: Measurement.

- A. Explain how a small error in measurement may lead to a large error in calculated results. I-D
- B. Calculate relative error. III-C
- C. Explain the difference between absolute error and relative error in measurement. III-D
- D. Give examples of how the same absolute error can be problematic in one situation but not in another; e.g., compare "accurate to the nearest foot" when measuring the height of a person versus when measuring the height of a mountain. III-D

- E. Determine the measures of central and inscribed angles and their associated major and minor arcs. III-C

Benchmarks for Standard III:

- Solve increasingly complex non-routine measurement problems and check for reasonableness of results.
- Use proportional reasoning and apply indirect measurement techniques, including right triangle trigonometry and properties of similar triangles, to solve problems involving measurements and rates.

Standard IV: Geometry and Spatial Sense.

- A. Formally define and explain key aspects of geometric figures, including: IV-H
 1. interior and exterior angles of polygons;
 2. segments related to triangles (median, altitude, midsegment);
 3. points of concurrency related to triangles (centroid, incenter, orthocenter, circumcenter);
 4. circles (radius, diameter, chord, circumference, major arc, minor arc, sector, segment, inscribed angle).
- B. Recognize and explain the necessity for certain terms to remain undefined, such as point, line and plane. IV-H
- C. 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, including: IV-H
 1. prove the Pythagorean Theorem;
 2. prove theorems involving triangle similarity and congruence;
 3. prove theorems involving properties of lines, angles, triangles and quadrilaterals;
 4. test a conjecture using basic constructions made with a compass and straightedge or technology.

- D. Construct right triangles, equilateral triangles, parallelograms, trapezoids, rectangles, rhombuses, squares and kites, using compass and straightedge or dynamic geometry software. IV-E
- E. Construct congruent figures and similar figures using tools, such as compass, straightedge, and protractor or dynamic geometry software. IV-E
- F. Identify the reflection and rotation symmetries of two- and three-dimensional figures. IV-F
- G. Perform reflections and rotations using compass and straightedge constructions and dynamic geometry software. IV-F
- H. Derive coordinate rules for translations, reflections and rotations of geometric figures in the coordinate plane. IV-B
- I. Show and describe 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. IV-F
- J. Solve problems involving chords, radii, and arcs within the same circle. IV-I

Benchmarks for Standard IV:

- **Formally define geometric figures.**
- **Describe and apply the properties of similar and congruent figures; and justify conjectures involving similarity and congruence.**
- **Use coordinate geometry to represent and examine the properties of geometric figures.**
- **Draw and construct representations of two and three-dimensional objects using a variety of tools, such as straightedge, compass and technology.**
- **Represent and model transformations in a coordinate plane and describe the results.**
- **Prove or disprove conjectures and solve problems involving two- and three-dimensional objects represented within a coordinate system.**
- **Establish the validity of conjectures about geometric objects, their properties and relationships by counter-example, inductive and deductive reasoning, and critiquing arguments made by others.**

- **Use right triangle trigonometric relationships to determine lengths and angle measurements.**

Standard V: Patterns, Functions and Algebra

- A. Define function formally and with $f(x)$ notation. V-D
- B. Describe and compare characteristics of the following families of functions: square root, cubic, absolute value and basic trigonometric functions; e.g., general shape, possible number of roots, domain and range. V-A
- C. Solve equations and formulas for a specified variable; e.g., express the base of a triangle in terms of the area and height. V-J
- D. Use algebraic representations and functions to describe and generalize geometric properties and relationships. V-D
- E. Solve simple linear and nonlinear equations and inequalities having square roots as coefficients and solutions. V-J
- F. Solve equations and inequalities having rational expressions as coefficients and solutions. V-J
- G. Solve systems of linear inequalities. V-J
- H. Graph the quadratic relationship that defines circles. V-E
 - I. Recognize and explain that the slopes of parallel lines are equal and the slopes of perpendicular lines are negative reciprocals. V-G
- J. Solve real-world problems that can be modeled using linear, quadratic, exponential or square root functions. V-L
- K. Solve real-world problems that can be modeled, using systems of linear equations and inequalities. V-L
- L. Describe the relationship between slope of a line through the origin and the tangent function of the angle created by the line and the positive x-axis. V-K

Standard VI: Data Analysis and Probability

- A. Describe measures of center and the range verbally, graphically and algebraically. VI-C
- B. Represent and analyze bivariate data using appropriate graphical displays (scatterplots, parallel box-and-whisker plots, histograms with more than one set of data, tables, charts, spreadsheets) with and without technology. VI-C

- C. Display bivariate data where at least one variable is categorical. VI-B
- D. Identify outliers on a data display; e.g., use interquartile range to identify outliers on a box-and-whisker plot. VI-A
- E. Provide examples and explain how a statistic may or may not be an attribute of the entire population; e.g., intentional or unintentional bias may be present. VI-E
- F. Interpret the relationship between two variables using multiple graphical displays and statistical measures; e.g., scatterplots, parallel box-and-whisker plots, and measures of center and spread. VI-
- G. Model problems dealing with uncertainty with area models (geometric probability). VI-G
- H. Differentiate and explain the relationship between the probability of an event and the odds of an event, and compute one given the other. VI-H

Benchmark for Standard VI:

- **Use counting techniques, such as permutations and combinations, to determine the total number of options and possible outcomes.**

Key to using this document:

- **Items in bold with Roman numerals are COS standards.**

- **Items that are bolded without Roman numerals are benchmarks.**

- Items in regular print are state grade level indicators with the COS letter/number correlation.

- *Items in italics are in the Diocesan Course of Study, not in state standards.*