

**Mathematics Curriculum Content Standards**

The process standards of **problem solving, reasoning and proof, connections communication, and representation** are interwoven and independent with the content standards and are necessary for the comprehensive understanding of mathematics.

Strand: **M1 Numbers and Operations**

Pre-Kindergarten through Grade 12 instructional programs should enable all students to:

- understand numbers, ways of representing numbers, relationships among numbers, and number systems;
- understand meanings of operations and how they relate to one another;
- understand how to compute fluently and make reasonable estimates.

In Grades 9–12, all students should:

- Standards:
- M1a:** connect physical, verbal and symbolic representations of irrational numbers and properties of special numbers, i.e., , ;
  - M1b:** compare, order, and determine equivalent forms for rational and irrational numbers;
  - M1c:** define the concept of complex numbers in the context of the square root of a negative number;
  - M1d:** using powers and roots including rational exponents, simplify number expressions;
  - M1e:** define the properties of matrices;
  - M1f:** identify and explain which mathematical properties hold for a given set or operations for the real number system, i.e., density, closure, commutative, associative, distributive;
  - M1g:** solve equations and inequalities using the inverse relationship of operations to include powers and roots;
  - M1h:** organize and analyze data using the operations of addition, subtraction, and scalar multiplication for matrices;
  - M1i:** estimate the approximate value of square and cube roots without the use of a calculator;
  - M1j:** use estimation to judge the reasonableness of numerical computations and their results;
  - M1k:** develop fluency in operations with real numbers using mental computation, paper and pencil calculations, and technology;
  - M1l:** Use properties of the number system to judge the validity of results and justify each step of a procedure.

Strand: **M2 Algebra**

Pre-Kindergarten through Grade 12 instructional programs should enable all students to:

- understand patterns, relations, and functions;
- represent and analyze mathematical situations and structures using algebraic symbols;
- use mathematical models to represent and understand quantitative relationships;
- analyze change in various contexts.

In Grades 9–12, all students should:

- Standards:
- M2a:** analyze, generalize, and create a variety of mathematical patterns;

- M2b:** analyze, interpret, and translate between relationships of patterns, functions, and relationships represented in tables, graphs, and matrices;
- M2c:** identify, describe, and compare the characteristics and properties of functions and relations including linear and nonlinear;
- M2d:** represent linear and nonlinear functions with tables, graphs, verbal rules, and symbolic rules and interpret these representations;
- M2e:** use algebraic representations and functions to generalize geometric properties and relationships;
- M2f:** write, solve, and interpret the relationship of equivalent forms for equations, inequalities, and systems of equations;
- M2g:** explain and demonstrate the relationship between various representations of a linear equation;
- M2h:** add, subtract, and multiply polynomials and divide polynomials by monomials;
- M2i:** translate between numeric and symbolic form of a sequence or series;
- M2j:** apply direct and inverse variation to both real-world and mathematical models;
- M2k:** solve and analyze real-world problems that can be modeled using linear, and nonlinear functions;
- M2l:** solve and analyze real-world problems that can be modeled using systems of equations and inequalities;
- M2m:** predict a reasonable conclusion for a problem being modeled, and verify the conclusion through solving the problem;
- M2n:** approximate and interpret rates of change from graphical and numerical data;
- M2o:** identify and explain how changes in parameters affect graphs of functions;
- M2p:** explain and graph the relationship between two variables for linear, periodic exponential, quadratic relationships and a limiting value.

Strand:

### **M3 Geometry**

Pre-Kindergarten through Grade 12 instructional programs should enable all students to:

- analyze characteristics and properties of two- and three- dimensional geometric shapes and develop mathematical arguments about geometric relationships;
- specify locations and describe spatial relationships using coordinate geometry and other representational systems;
- apply transformations and use symmetry to analyze mathematical situations;
- use visualization, spatial reasoning, and geometric modeling to solve problems.

In Grades 9–12, all students should:

Standards:

- M3a:** identify undefined terms and explain the need for undefined terms;

- M3b:** use a variety of ways to represent geometric ideas and recognize relationships among them including coordinates, networks, transformations, and matrices;
- M3c:** identify and explain relationships among classes of two- and three-dimensional geometric objects, i.e., sides, angles, etc.;
- M3d:** make conjectures, test, and prove relationships among two- and three-dimensional geometric objects, i.e., congruent triangles;
- M3e:** distinguish between postulates and theorems and apply them appropriately;
- M3f:** identify and explain examples of induction and deductive;
- M3g:** analyze geometric situations using Cartesian coordinates and other appropriate coordinate systems;
- M3h:** use rectangular coordinates; calculate midpoints of segments, slopes of lines and segments, and distances between two points to solve problems;
- M3h:** use sketches, coordinates, function notation, and matrices to represent translations, reflections, rotations, and dilations of objects in the plane;
- M3i:** draw and construct representations for two- dimensional objects using a variety of tools;
- M3j:** construct vertex-edge graphs to model and solve problems;
- M3k:** identify and explain projections and cross sections by visualizing different perspectives of three- dimensional objects and spaces;
- M3l:** Solve problems by applying properties and theorems of lines, angles, polygons, and circles.

Strand:

#### **M4 Measurement**

Pre-Kindergarten through Grade 12 instructional programs should enable all students to:

- understand measurable attributes of objects and the units, systems, and processes of measurement;
- apply appropriate techniques, tools, and formulas to determine measurements.

In Grades 9–12, all students should:

Standards:

- M4a:** use the appropriate unit or dimensional analysis in measurement situations;
- M4b:** explain the effect of changes in the measurement of one attribute of an object relating to changes on other attributes;
- M4c:** recognize and apply alternative methods of measurement;
- M4d:** apply appropriate formulas for the area, surface area, and volume of geometric figures, including cones, spheres, and cylinders;
- M4e:** analyze and explain precision, accuracy, and approximate error in measurement situations.

Strand:

#### **M5 Data Analysis and Probability**

Pre-Kindergarten through Grade 12 instructional programs should enable all students to:

- formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them;
- select and use appropriate statistical methods to analyze data;

- develop and evaluate inferences and predictions that are based on data;
- understand and apply basic concepts of probability.

In Grades 9–12, all students should:

- Standards:
- M5a:** classify and describe data as single (univariate) or two variable (bivariate) and as quantitative (measurement) or qualitative (categorical) data;
  - M5b:** design surveys and apply random sampling techniques to avoid bias in data collection;
  - M5c:** use multiple graphical displays and statistical measures to display and interpret the relationship between two variables;
  - M5d:** compare different sets of data by using summary statistics and select the appropriate graphical representation;
  - M5e:** explain the ways representations can skew data or bias presentations;
  - M5f:** describe and explain the characteristics and limitations of various sampling methods;
  - M5g:** describe and explain how the validity of predictions from a data set are affected by the relative size of a sample and the population;
  - M5h:** use counting techniques and/or combinations to solve explain probability problems;
  - M5i:** describe, create, and analyze a sample space, then calculate the probability;
  - M5j:** use the concept of conditional probability and independent events to apply and interpret the results of a set;
  - M5k:** calculate and explain the probability of compound events;
  - M5l:** use sampling or simulation to construct empirical probability distributions to compare and explain corresponding theoretical probabilities;
  - M5m:** differentiate and explain the relationship between the probability of an event and the odds of an event.

Strand: **M6 Problem Solving**

- Standard:
- M6a:** Pre-Kindergarten through Grade 12 instructional programs should enable all students to:
    - build new mathematical knowledge through problem solving;
    - solve problems that arise in mathematics and in other contexts;
    - apply and adapt a variety of appropriate strategies to solve problems;
    - monitor and reflect on the process of mathematical problem solving.

Strand: **M7 Reasoning and Proof**

- Standard:
- M7a:** Pre-Kindergarten through Grade 12 instructional programs should enable all students to:
    - recognize reasoning and proof as fundamental aspects of mathematics;
    - make and investigate mathematical conjectures;
    - develop and evaluate mathematical arguments and proofs;

- select and use various types of reasoning and methods of proof.

Strand: **M8 Communication**

- Standard: **M8a:** Pre-Kindergarten through Grade 12 instructional programs should enable all students to:
- organize and consolidate their mathematical thinking through communication;
  - communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
  - analyze and evaluate the mathematical thinking and strategies of others;
  - use the language of mathematics to express mathematical ideas precisely.

Strand: **M9 Connections**

- Standard: **M9a:** Pre-Kindergarten through Grade 12 instructional programs should enable all students to:
- recognize and use connections among mathematical ideas;
  - understand how mathematical ideas interconnect and build on one another to produce a coherent whole;
  - recognize and apply mathematics in contexts outside of mathematics.

Strand: **M10 Representation**

- Standard: **M10a:** Pre-Kindergarten through Grade 12 instructional programs should enable all students to:
- create and use representations to organize, record, and communicate mathematical ideas;
  - select, apply, and translate among mathematical representations to solve problems;
  - use representations to model and interpret physical, social, and mathematical phenomena.