

MATHEMATICS STANDARD

Grade – Tenth

Standard

Benchmark

Indicators

**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.

By the end of the 8 – 10 program, students will . . .

- 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.
- E. Compare, order and determine equivalent forms of real numbers.
- F. Explain the effects of operations on the magnitude of quantities.
- G. Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions.
- H. Find the square root of perfect squares, and approximate the square root of non-perfect squares.
- I. Estimate, compute and solve problems involving scientific notation, square roots and numbers with integer exponents.

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

MATHEMATICS STANDARD

Grade – Tenth

Standard

Benchmark

Indicators

**Measurement Standard**

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

By the end of the 8 – 10 program, students will . . .

- 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 to a specified level of precision.
- 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 prisms, 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 measurements and rates.
- E. Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.
- F. Write and solve real-world, multi-step problems involving money, elapsed time and temperature, and verify reasonableness of solutions.

- 1.Explain how a small error in measurement may lead to a large error in calculated results.
- 2.Calculate relative error.
- 3.Explain the difference between absolute error and relative error in measurement.
- 4.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.
- 5. Determine the measures of central and inscribed angles and their associated major and minor arcs.

MATHEMATICS STANDARD

Grade – Tenth

Standard

Benchmark

Indicators

**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.

By the end of the 8 – 10 program, students will . . .

- 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, such as straightedge, compass and technology.
- 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.

- 1. Formally define and explain key aspects of geometric figures, including:
  - a. interior and exterior angles of polygons;
  - b. segments related to triangles (median, altitude, midsegment);
  - c. points of concurrency related to triangles (centroid, incenter, orthocenter, circumcenter);
  - d. circles (radius, diameter, chord, circumference, major arc, minor arc, sector, segment, inscribed angle).
- 2. Recognize and explain the necessity for certain terms to remain undefined, such as point, line and plane.
- 3. Make, test and establish the validity of conjectures about geometric properties and relationships using counterexample, inductive and deductive reasoning, and paragraph or two-column proof, including:
  - a. prove the Pythagorean Theorem;
  - b. prove theorems involving triangle similarity and congruence;
  - c. prove theorems involving properties of lines, angles, triangles and quadrilaterals;
  - d. test a conjecture using basic constructions made with a compass and straightedge or technology.

MATHEMATICS STANDARD

Grade – Tenth

Standard

Benchmark

Indicators

By the end of the 8 – 10 program,  
students will . . .

I. Use right triangle trigonometric  
relationships to determine lengths and  
angle measures.

- 4. Construct right triangles, equilateral triangles, parallelograms, trapezoids, rectangles, rhombuses, squares and kites, using compass and straightedge or dynamic geometry software.
- 5. Construct congruent figures and similar figures using tools, such as compass, straightedge, and protractor or dynamic geometry software.
- 6. Identify the reflection and rotation symmetries of two- and three-dimensional figures.
- 7. Perform reflections and rotations using compass and straightedge constructions and dynamic geometry software.
- 8. Derive coordinate rules for translations, reflections and rotations of geometric figures in the coordinate plane.
- 9. 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.
- 10. Solve problems involving chords, radii and arcs within the same circle.

MATHEMATICS STANDARD

Grade – Tenth

Standard

Benchmark

Indicators

By the end of the 8 – 10 program, students will . . .

**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.

- A. Generalize and explain patterns and sequences in order to find the next term and the  $n$ th 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, graph or equation) to another representation of a relation or function.
- D. Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.
- E. Analyze and compare functions and their graphs using attributes, such as rates of change, intercepts and zeros.
- 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 variation.

- 1. Define function formally and with  $f(x)$  notation.
- 2. 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.
- 3. Solve equations and formulas for a specified variable; e.g., express the base of a triangle in terms of the area and height.
- 4. Use algebraic representations and functions to describe and generalize geometric properties and relationships.
- 5. Solve simple linear and nonlinear equations and inequalities having square roots as coefficients and solutions.
- 6. Solve equations and inequalities having rational expressions as coefficients and solutions.
- 7. Solve systems of linear inequalities.
- 8. Graph the quadratic relationship that defines circles.
- 9. Recognize and explain that the slopes of parallel lines are equal and the slopes of perpendicular lines are negative reciprocals.

MATHEMATICS STANDARD

Grade – Tenth

Standard

Benchmark

Indicators

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By the end of the 8 – 10 program,  
students will . . .

J. Describe and interpret rates of  
change from graphical and numerical  
data.

- 10. Solve real-world problems that can be modeled using linear, quadratic, exponential or square root functions.
- 11. Solve real-world problems that can be modeled, using systems of linear equations and inequalities.
- 12. 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.

MATHEMATICS STANDARD

Grade – Tenth

Standard

Benchmark

Indicators

**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.

By the end of the 8 – 10 program, students will . . .

- A. Create, interpret and use graphical displays and statistical measures to describe data; e.g., box-and-whisker plots, histograms, scatterplots, measures of center and variability.
- B. Evaluate different graphical representations of the same data to determine which is the most appropriate representation for an 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, such as mean and quartiles, 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 examining the appropriateness of the data collection and analysis.
- 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.

- 1. Describe measures of center and the range verbally, graphically and algebraically.
- 2. 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.
- 3. Display bivariate data where at least one variable is categorical.
- 4. Identify outliers on a data display; e.g., use interquartile range to identify outliers on a box-and-whisker plot.
- 5. 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.
- 6. 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.
- 7. Model problems dealing with uncertainty with area models (geometric probability).

MATHEMATICS STANDARD

Grade – Tenth

Standard

Benchmark

Indicators

---

By the end of the 8 – 10 program,  
students will . . .

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

I. Design an experiment to test a theoretical probability, and record and explain results.

J. Compute probabilities of compound events, independent events, and simple dependent events.

K. Make predictions based on theoretical probabilities and experimental results.

8. Differentiate and explain the relationship between the probability of an event and the odds of an event, and compute one given the other.

MATHEMATICS STANDARD

Grade – Tenth

Standard

Benchmark

Indicators

---

By the end of the 8 – 10 program,  
students will . . .

**Mathematical Processes Standard**

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

- A. Formulate a problem or mathematical model in response to a specific need or situation, determine information required solving the problem, choosing method for obtaining this information, and set limits for acceptable solution.
- 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., zero of a function and the x-intercept of the graph of the function, apply proportional thinking when measuring, describing functions, and comparing probabilities.
- D. Apply reasoning processes 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.

MATHEMATICS STANDARD

Grade – Tenth

Standard

Benchmark

Indicators

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By the end of the 8 – 10 program,  
students will . . .

- F. Use precise mathematical language and notations to represent problem situations and mathematical ideas.
- 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 easily understood manner.