

# Minnesota K-12 Academic Standards in Mathematics

April 14, 2007 Revision

Grades 5-11

Sorted by Standard:

1. Number & Operation
2. Algebra
3. Geometry and Measurement
4. Data Analysis

	Geometry & Measurement	Describe, classify, and draw representations of three-dimensional figures.	5.3.1.1	Describe and classify three-dimensional figures including cubes, prisms and pyramids by the number of edges, faces or vertices as well as the types of faces.
			5.3.1.2	Recognize and draw a net for a three-dimensional figure.
			5.3.2.1	Develop and use formulas to determine the area of triangles, parallelograms and figures that can be decomposed into triangles.
			5.3.2.2	Determine the surface area of a rectangular prism by applying various strategies. <i>For example:</i> Use a net or decompose the surface into rectangles.
5	Geometry & Measurement	Determine the area of triangles and quadrilaterals; determine the surface area and volume of rectangular prisms in various contexts.	5.3.2.3	Understand that the volume of a three-dimensional figure can be found by counting the total number of same-size cubic units that fill a shape without gaps or overlaps. Use cubic units to label volume measurements. <i>For example:</i> Use cubes to find the volume of a small fish tank.
			5.3.2.4	Develop and use the formulas $V = \ell wh$ and $V = Bh$ to determine the volume of rectangular prisms. Justify why base area $B$ and height $h$ are multiplied to find the volume of a rectangular prism by breaking the prism into layers of unit cubes.
			5.3.2.5	Use various tools to measure the volume and surface area of various objects that are shaped like rectangular prisms. <i>For example:</i> Measure the surface area of a cereal box by cutting it into rectangles. <i>Another example:</i> Measure the volume of a cereal box by using a ruler to measure its height, width and length, or by filling it with cereal and then emptying the cereal into containers of known volume.

6	Geometry & Measurement	Calculate perimeter, area, surface area and volume of two- and three-dimensional figures to solve real-world and mathematical problems.	6.3.1.1	<p>Calculate the surface area and volume of prisms and use appropriate units, such as <math>\text{cm}^2</math> and <math>\text{cm}^3</math>. Justify the formulas used. Justification may involve decomposition, nets or other models.</p> <p><i>For example:</i> The surface area of a triangular prism can be derived by decomposing the surface into two triangles and three rectangles.</p>
			6.3.1.2	<p>Calculate the area of quadrilaterals. Quadrilaterals include squares, rectangles, rhombuses, parallelograms, trapezoids and kites. When formulas are used, be able to explain why they are valid.</p> <p><i>For example:</i> The area of a kite is one-half the product of the lengths of the diagonals, and this can be justified by decomposing the kite into two triangles.</p>
			6.3.1.3	<p>Estimate the perimeter and area of irregular figures on a grid when they cannot be decomposed into common figures and use correct units, such as <math>\text{cm}</math> and <math>\text{cm}^2</math>.</p>
	Understand and use relationships between angles in geometric figures.	6.3.2.1	<p>Solve problems using the relationships between the angles formed by intersecting lines.</p> <p><i>For example:</i> If two streets cross, forming four corners such that one of the corners forms an angle of <math>120^\circ</math>, determine the measures of the remaining three angles.</p> <p><i>Another example:</i> Recognize that pairs of interior and exterior angles in polygons have measures that sum to <math>180^\circ</math>.</p>	
		6.3.2.2	<p>Determine missing angle measures in a triangle using the fact that the sum of the interior angles of a triangle is <math>180^\circ</math>. Use models of triangles to illustrate this fact.</p> <p><i>For example:</i> Cut a triangle out of paper, tear off the corners and rearrange these corners to form a straight line.</p> <p><i>Another example:</i> Recognize that the measures of the two acute angles in a right triangle sum to <math>90^\circ</math>.</p>	
		6.3.2.3	<p>Develop and use formulas for the sums of the interior angles of polygons by decomposing them into triangles.</p>	
	Choose appropriate units of measurement and use ratios to convert within measurement systems to solve real-world and mathematical problems.	6.3.3.1	<p>Solve problems in various contexts involving conversion of weights, capacities, geometric measurements and times within measurement systems using appropriate units.</p>	
		6.3.3.2	<p>Estimate weights, capacities and geometric measurements using benchmarks in measurement systems with appropriate units.</p> <p><i>For example:</i> Estimate the height of a house by comparing to a 6-foot man standing nearby.</p>	

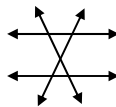
7	Geometry & Measurement	Use reasoning with proportions and ratios to determine measurements, justify formulas and solve real-world and mathematical problems involving circles and related geometric figures.	7.3.1.1	Demonstrate an understanding of the proportional relationship between the diameter and circumference of a circle and that the unit rate (constant of proportionality) is $\pi$ . Calculate the circumference and area of circles and sectors of circles to solve problems in various contexts.
			7.3.1.2	Calculate the volume and surface area of cylinders and justify the formulas used. <i>For example:</i> Justify the formula for the surface area of a cylinder by decomposing the surface into two circles and a rectangle.
		Analyze the effect of change of scale, translations and reflections on the attributes of two-dimensional figures.	7.3.2.1	Describe the properties of similarity, compare geometric figures for similarity, and determine scale factors. <i>For example:</i> Corresponding angles in similar geometric figures have the same measure.
			7.3.2.2	Apply scale factors, length ratios and area ratios to determine side lengths and areas of similar geometric figures. <i>For example:</i> If two similar rectangles have heights of 3 and 5, and the first rectangle has a base of length 7, the base of the second rectangle has length $\frac{35}{3}$ .
			7.3.2.3	Use proportions and ratios to solve problems involving scale drawings and conversions of measurement units. <i>For example:</i> 1 square foot equals 144 square inches. <i>Another example:</i> In a map where 1 inch represents 50 miles, $\frac{1}{2}$ inch represents 25 miles.
7.3.2.4	Graph and describe translations and reflections of figures on a coordinate grid and determine the coordinates of the vertices of the figure after the transformation. <i>For example:</i> The point (1, 2) moves to (-1, 2) after reflection about the y-axis.			

Geometry & Measurement	Solve problems involving right triangles using the Pythagorean Theorem and its converse.	8.3.1.1	Use the Pythagorean Theorem to solve problems involving right triangles. <i>For example:</i> Determine the perimeter of a right triangle, given the lengths of two of its sides. <i>Another example:</i> Show that a triangle with side lengths 4, 5 and 6 is not a right triangle.
		8.3.1.2	Determine the distance between two points on a horizontal or vertical line in a coordinate system. Use the Pythagorean Theorem to find the distance between any two points in a coordinate system.
		8.3.1.3	Informally justify the Pythagorean Theorem by using measurements, diagrams and computer software.

		Solve problems involving parallel and perpendicular lines on a coordinate system.	8.3.2.1	Understand and apply the relationships between the slopes of parallel lines and between the slopes of perpendicular lines. Dynamic graphing software may be used to examine the relationships between lines and their equations.
8	Geometry & Measurement	Solve problems involving parallel and perpendicular lines on a coordinate system.	8.3.2.2	Analyze polygons on a coordinate system by determining the slopes of their sides. <i>For example:</i> Given the coordinates of four points, determine whether the corresponding quadrilateral is a parallelogram.
			8.3.2.3	Given a line on a coordinate system and the coordinates of a point not on the line, find lines through that point that are parallel and perpendicular to the given line, symbolically and graphically.

9, 10, 11	Geometry & Measurement	Calculate measurements of plane and solid geometric figures; know that physical measurements depend on the choice of a unit and that they are approximations.	9.3.1.1	Determine the surface area and volume of pyramids, cones and spheres. Use measuring devices or formulas as appropriate. <i>For example:</i> Measure the height and radius of a cone and then use a formula to find its volume.
			9.3.1.2	Compose and decompose two- and three-dimensional figures; use decomposition to determine the perimeter, area, surface area and volume of various figures. <i>For example:</i> Find the volume of a regular hexagonal prism by decomposing it into six equal triangular prisms.
			9.3.1.3	Understand that quantities associated with physical measurements must be assigned units; apply such units correctly in expressions, equations and problem solutions that involve measurements; and convert between measurement systems. <i>For example:</i> $60 \text{ miles/hour} = 60 \text{ miles/hour} \times 5280 \text{ feet/mile} \times 1 \text{ hour}/3600 \text{ seconds} = 88 \text{ feet/second}$ .
			9.3.1.4	Understand and apply the fact that the effect of a scale factor $k$ on length, area and volume is to multiply each by $k$ , $k^2$ and $k^3$ , respectively.
9, 10, 11	Geometry & Measurement	Calculate measurements of plane and solid geometric figures; know that physical measurements depend on the choice of a unit and that they are approximations.	9.3.1.5	Make reasonable estimates and judgments about the accuracy of values resulting from calculations involving measurements. <i>For example:</i> Suppose the sides of a rectangle are measured to the nearest tenth of a centimeter at 2.6 cm and 9.8 cm. Because of measurement errors, the width could be as small as 2.55 cm or as large as 2.65 cm, with similar errors for the height. These errors affect calculations. For instance, the actual area of the rectangle could be smaller than $25 \text{ cm}^2$ or larger than $26 \text{ cm}^2$ , even though $2.6 \times 9.8 = 25.48$ .

9, 10, 11	Geometry & Measuremen	Construct logical arguments, based on axioms, definitions and theorems, to prove theorems and other results in geometry.	9.3.2.1	Understand the roles of axioms, definitions, undefined terms and theorems in logical arguments.
			9.3.2.2	Accurately interpret and use words and phrases in geometric proofs such as "if...then," "if and only if," "all," and "not." Recognize the logical relationships between an "if...then" statement and its inverse, converse and contrapositive. <i>For example:</i> The statement "If you don't do your homework, you can't go to the dance" is not logically equivalent to its inverse "If you do your homework, you can go to the dance."
			9.3.2.3	Assess the validity of a logical argument and give counterexamples to disprove a statement.
			9.3.2.4	Construct logical arguments and write proofs of theorems and other results in geometry, including proofs by contradiction. Express proofs in a form that clearly justifies the reasoning, such as two-column proofs, paragraph proofs, flow charts or illustrations. <i>For example:</i> Prove that the sum of the interior angles of a pentagon is $540^\circ$ using the fact that the sum of the interior angles of a triangle is $180^\circ$ .
			9.3.2.5	Use technology tools to examine theorems, test conjectures, perform constructions and develop mathematical reasoning skills in multi-step problems. The tools may include compass and straight edge, dynamic geometry software, design software or Internet applets.

9, 10, 11	Geometry & Measurement	Know and apply properties of geometric figures to solve real-world and mathematical problems and to logically justify results in geometry.	9.3.3.1	Know and apply properties of parallel and perpendicular lines, including properties of angles formed by a transversal, to solve problems and logically justify results. <i>For example:</i> Prove that the perpendicular bisector of a line segment is the set of all points equidistant from the two endpoints, and use this fact to solve problems and justify other results.
9, 10, 11	Geometry & Measurement	Know and apply properties of geometric figures to solve real-world and mathematical problems and to logically justify results in geometry.	9.3.3.2	Know and apply properties of angles, including corresponding, exterior, interior, vertical, complementary and supplementary angles, to solve problems and logically justify results. <i>For example:</i> Prove that two triangles formed by a pair of intersecting lines and a pair of parallel lines (an "X" trapped between two parallel lines) are similar. 

9, 10, 11	Geometry & Measuremen	Know and apply properties of geometric figures to solve real-world and mathematical problems and to logically justify results in geometry.	9.3.3.3	<p>Know and apply properties of equilateral, isosceles and scalene triangles to solve problems and logically justify results.</p> <p><i>For example:</i> Use the triangle inequality to prove that the perimeter of a quadrilateral is larger than the sum of the lengths of its diagonals.</p>
			9.3.3.4	<p>Apply the Pythagorean Theorem and its converse to solve problems and logically justify results.</p> <p><i>For example:</i> When building a wooden frame that is supposed to have a square corner, ensure that the corner is square by measuring lengths near the corner and applying the Pythagorean Theorem.</p>
			9.3.3.5	<p>Know and apply properties of right triangles, including properties of 45-45-90 and 30-60-90 triangles, to solve problems and logically justify results.</p> <p><i>For example:</i> Use 30-60-90 triangles to analyze geometric figures involving equilateral triangles and hexagons.</p> <p><i>Another example:</i> Determine exact values of the trigonometric ratios in these special triangles using relationships among the side lengths.</p>
			9.3.3.6	<p>Know and apply properties of congruent and similar figures to solve problems and logically justify results.</p> <p><i>For example:</i> Analyze lengths and areas in a figure formed by drawing a line segment from one side of a triangle to a second side, parallel to the third side.</p> <p><i>Another example:</i> Determine the height of a pine tree by comparing the length of its shadow to the length of the shadow of a person of known height.</p> <p><i>Another example:</i> When attempting to build two identical 4-sided frames, a person measured the lengths of corresponding sides and found that they matched. Can the person conclude that the shapes of the frames are congruent?</p>
			9.3.3.7	<p>Use properties of polygons—including quadrilaterals and regular polygons—to define them, classify them, solve problems and logically justify results.</p> <p><i>For example:</i> Recognize that a rectangle is a special case of a trapezoid.</p> <p><i>Another example:</i> Give a concise and clear definition of a kite.</p>
9, 10, 11	Geometry & Measurement	Know and apply properties of geometric figures to solve real-world and mathematical problems and to logically justify results in geometry.	9.3.3.8	<p>Know and apply properties of a circle to solve problems and logically justify results.</p> <p><i>For example:</i> Show that opposite angles of a quadrilateral inscribed in a circle are supplementary.</p>

9, 10, 11	Geometry & Measurement	Solve real-world and mathematical geometric problems using algebraic methods.	9.3.4.1	Understand how the properties of similar right triangles allow the trigonometric ratios to be defined, and determine the sine, cosine and tangent of an acute angle in a right triangle.
			9.3.4.2	Apply the trigonometric ratios sine, cosine and tangent to solve problems, such as determining lengths and areas in right triangles and in figures that can be decomposed into right triangles. Know how to use calculators, tables or other technology to evaluate trigonometric ratios.  <i>For example:</i> Find the area of a triangle, given the measure of one of its acute angles and the lengths of the two sides that form that angle.
			9.3.4.3	Use calculators, tables or other technologies in connection with the trigonometric ratios to find angle measures in right triangles in various contexts.
			9.3.4.4	Use coordinate geometry to represent and analyze line segments and polygons, including determining lengths, midpoints and slopes of line segments.
			9.3.4.5	Know the equation for the graph of a circle with radius $r$ and center $(h,k)$ , $(x - h)^2 + (y - k)^2 = r^2$ , and justify this equation using the Pythagorean Theorem and properties of translations.
			9.3.4.6	Use numeric, graphic and symbolic representations of transformations in two dimensions, such as reflections, translations, scale changes and rotations about the origin by multiples of $90^\circ$ , to solve problems involving figures on a coordinate grid.  <i>For example:</i> If the point $(3,-2)$ is rotated $90^\circ$ counterclockwise about the origin, it becomes the point $(2,3)$ .
			9.3.4.7	Use algebra to solve geometric problems unrelated to coordinate geometry, such as solving for an unknown length in a figure involving similar triangles, or using the Pythagorean Theorem to obtain a quadratic equation for a length in a geometric figure.