New York State Testing Program
Next Generation Mathematics Test

Performance Level Descriptions

Geometry

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THE STATE EDUCATION DEPARTMENT / THE UNIVERSITY OF THE STATE OF NEW YORK /
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Geometry Performance Level Descriptions

Performance level descriptions (PLDs) help communicate to students, families, educators, and the public the specific knowledge and skills expected of students when they demonstrate proficiency of a learning standard. The PLDs serve several purposes in classroom instruction and assessment. They are the foundation of rich discussion around what students need to do to perform at higher levels and to explain the progression of learning within a subject area. PLDs are also crucial in explaining student performance on the NYS assessments since they make a connection between the scale score, the performance level, and specific knowledge and skills typically demonstrated at that level.

Policy Definitions of Performance Levels

For each subject area, students perform along a continuum of the knowledge and skills necessary to meet the demands of the Learning Standards for Mathematics. There are students who meet the expectations of the standards with distinction, students who fully meet the expectations, students who minimally meet the expectations, students who partially meet the expectations, and students who do not demonstrate sufficient knowledge or skills required for any performance level. New York State assessments are designed to classify student performance into one of five levels based on the knowledge and skills the student has demonstrated.

NYS Level 5

Students performing at this level meet the expectations of the Mathematics Learning Standards **with distinction** for Geometry.

NYS Level 4

Students performing at this level **fully meet** the expectations of the Mathematics Learning Standards for Geometry. They are likely prepared to succeed in the next level of coursework.

NYS Level 3

Students performing at this level **minimally meet** the expectations of the Mathematics Learning Standards for Geometry. They meet the content area requirements for a Regents diploma but may need additional support to succeed in the next level of coursework.

NYS Level 2

Students performing at this level **partially meet** the expectations of the Mathematics Learning Standards for Geometry. Students with disabilities performing at this level meet the content area requirements for a local diploma but may need additional support to succeed in the next level of coursework.

NYS Level 1

Students performing at this level demonstrate knowledge, skills, and practices embodied by the Mathematics Learning Standards for Geometry below that of Level 2.

How were the PLDs developed?

Following best practice for the development of PLDs, the number of performance levels and their definitions were specified prior to the articulation of the full descriptions. The New York State Education Department convened a group of NYS mathematics educators to develop the initial draft PLDs for Geometry. In developing PLDs, participants considered policy definitions of the performance level and the knowledge and skill expectations for each grade level in the Learning Standards. Once they established the appropriate knowledge and skills from a particular standard for NYS Level 4 (fully meet), panelists worked together to parse the knowledge and skills across the other performance levels in such a way that the progression of the knowledge and skills was clearly seen moving from Level 2 to Level 5. This process was repeated for all the standards within the course. The draft PLDs then went through additional rounds of review and edits from a number of NYS-certified educators, content specialists, and assessment experts under NYSED supervision.

How can the PLDs be used by Educators and in Instruction?

The PLDs should be used as a guidance document to show the overall continuum of learning of the knowledge and skills from the Learning Standards. NYSED encourages the use of the PLDs for a variety of purposes, including differentiating instruction to maximize individual student outcomes, creating formative classroom assessments and rubrics to help identify target performance levels for individual or groups of students, and tracking student growth along the proficiency continuum as described by the PLDs. The knowledge and skills shown in the PLDs describe typical performance and progression, however the order in which students will demonstrate the knowledge and skills within and between performance levels may be staggered (i.e., a student who predominantly demonstrates Level 3 knowledge and skills may simultaneously demonstrate certain knowledge and skills indicative of Level 4).

How are the PLDs used in Assessment?

PLDs are essential in setting performance standards (i.e., “cut scores”) for New York State assessments. Standard setting panelists use PLDs to determine the expectations for students to demonstrate the knowledge and skills necessary to just barely attain a Level 3, Level 4, or Level 5 on the assessment. These skills and knowledge drive discussions that influence the panelists as they recommend the cut scores on the assessment. PLDs are also used in question development. Question writers are assigned to write questions that draw on the specific knowledge and skills from a PLD. This ensures that each test has questions that distinguish performance all along the continuum. Teachers can use the PLDs in the same manner when developing both formative and summative classroom assessments. Tasks that require students to demonstrate knowledge and skills from the PLDs can be tied back to the performance level with which the PLD is associated, providing the teacher with feedback about students’ progress as well as a wealth of other skills that students are likely able to demonstrate (or can aspire to in the case of the next-highest PLD).

Note: Certain level 5 PLDs will be denoted with a star indicating the knowledge and skills represented will not be targeted by questions on the NYS Geometry Regents Examination.

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
Experiment with transformations in the plane. **CO.A**			Identify a portion of a circle as an arc of the circle, and a portion of a line as a segment on the line.	Identify angles, circles, perpendicular lines, parallel lines, and line segments. Identify the sides and angles of figures.
	Explain why certain transformations preserve the characteristics of a figure (such as distance and angle measure) as opposed to the transformations that do not.	Compare transformations that preserve distance and angle measure to those that do not. Draw, graph or identify a transformation involving a horizontal and/or vertical stretch. (Ex: graphing a horizontal stretch of scale factor 2 with respect to $x = 0$ is a transformation that doubles each *x*-coordinate while each *y*-coordinate remains unchanged.)	Identify transformations that preserve distance and angle measure, as opposed to the transformations that do not. Identify when a transformation involves a horizontal stretch and/or a vertical stretch.	Identify the image of a point, an angle, or a line segment from a figure after a transformation. Identify non-congruent polygons from given diagrams using transformations.
		Determine all lines of symmetry for any irregular polygon. Describe the rotations and/or reflections (symmetries) that carry any polygon onto itself.	Determine all lines of symmetry for any regular polygon. Determine the minimum number of degrees required to carry a regular polygon onto itself when rotating the polygon about its center.	Determine horizontal and vertical lines of symmetry. Identify a figure that carries onto itself after a rotation of 90˚ or 180˚.

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
	Explain transformations using their properties (Ex: a line reflection is the perpendicular bisector of the segment joining a point to its image.)	Define rotations, reflections, and translations using points, angles, line segments, circles, and parallel and perpendicular lines. Describe transformations using reproducible terminology. (Ex: a translation left 3 units, a 90˚ counterclockwise rotation about the origin, or a reflection over the *x*-axis.)	Identify rotations, reflections, and translations. Describe transformations as translations, rotations, or reflections.	Describe transformations as shifts, slides, turns, or flips.
	Draw or graph the image of a given figure after a sequence of transformations, including a reflection over a line in the form $y = x + b$, where $b \neq 0$.	Draw or graph the image of a given figure after a reflection over $y = x$ or $y = -x$, or a 90˚ rotation about a point other than the origin. Draw or graph the image of a given figure after a sequence of transformations. Describe a reproducible sequence of transformations, on or off the coordinate plane, that will map a given figure onto another. (Ex: a translation left 3 units followed by a 90˚ counterclockwise rotation about the origin.)	Draw or graph the image of a given figure after a point reflection/180˚ rotation about a point other than the origin, a reflection over a horizontal or vertical line that is not the *x*- or *y*-axis, or a 90˚ rotation about the origin. Identify a sequence of transformations that maps one given figure onto another given figure, on or off the coordinate plane. (Ex: a translation followed by a rotation.)	Draw or graph the image of a given figure after a translation, a reflection over the *x*- or *y*-axis, or a point reflection through the origin/180˚ rotation about the origin.

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
Understand congruence in terms of rigid motions. CO.B		Explain why two (or more) given figures are congruent using the definition of congruence[1] when one figure can be mapped onto another figure.	Determine the effects of rigid motions on two or more figures, including preservation of distance, angle measure, and orientation.	Identify when distance and angle measure are preserved when given a figure and its image.
		Explain, using rigid motions, that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent. Determine a missing side length or angle measure algebraically when given two figures that can be mapped onto each other using rigid motions.	Determine, using rigid motions, that two triangles are congruent when all corresponding pairs of sides and all corresponding pairs of angles are congruent. Identify corresponding parts of two or more congruent triangles, where one triangle maps to the other using two or more rigid motions. Determine a missing side length or angle measure numerically when given two figures that can be mapped onto each other using rigid motions.	Identify corresponding parts of two congruent triangles, where one triangle maps to the other using a single rigid motion.
		Explain why triangles are congruent by ASA, SAS, SSS, AAS and HL, using rigid motions.	Determine if triangles are congruent based on properties of rigid motions using triangle congruence criteria (SSS, SAS, AAS, ASA, or HL) when given congruence statements of segments and/or angles.	Determine if two triangles are congruent based on the properties of rigid motions using triangle congruence criteria (SSS, SAS, AAS, ASA, or HL) when given a marked diagram.

[1] *A condition in which a finite sequence of rigid motions exists that maps one figure completely onto another figure.*

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
Prove geometric theorems. **CO.C**	Prove theorem(s) or solve problems by using auxiliary lines in diagrams.	Provide a complete line of geometric reasoning to prove a specific geometric statement or a stated geometric theorem.	Provide a partial line of geometric reasoning in an effort to prove a specific geometric statement.	Provide a correct geometric statement pertaining to the given geometric information.
		Apply theorems algebraically to represent geometric relationships within figures.	Apply theorems numerically to find segment lengths or angle measures.	Identify supplementary, complementary, vertical, adjacent, and linear pairs of angles. Identify the sum of the angle measures of a triangle. Identify angle pair relationships when parallel lines are cut by a transversal.
		Apply congruence theorems about triangles/figures to explain a geometric relationship.	Apply congruence theorems about triangles/figures to justify a geometric relationship.	Identify corresponding parts with two congruent triangles/figures.
Make geometric constructions. **CO.D**	Prove the validity of a construction.	Make, justify, and apply formal geometric constructions. (Including but not limited to a median of a triangle, a 45˚ angle, a point of concurrency of a triangle, the circumscribed circle of a triangle, a transformation of a figure.)	Construct the bisector of a given segment or angle. Construct a copy of a segment or angle. Construct a line perpendicular to a given segment or line through a point on or off the segment or line.	
		Make, justify, and apply the constructions for inscribing an equilateral triangle, a square, and a regular hexagon in a circle.		

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
Understand similarity in terms of similarity transformations. SRT.A	Explain how the location of the center affects the image of a dilated line. Explain how a dilation affects the area of a polygon.	Write an equation for a dilated line whose center of dilation is not on the line. Graph a dilation of a line segment in the coordinate plane not centered at the origin. Explain the effects of a dilation on the side lengths and perimeter of a polygon, including how a dilation of a line segment is related to its scale factor. Determine the area of a dilated figure given its preimage.	Write an equation for a dilated line whose center of dilation is on the line. Graph a dilation of a line segment in the coordinate plane centered at the origin. Determine that the dilation of a line segment is longer or shorter in the ratio given by the scale factor. Determine non-numeric ratios that represents the scale factor in dilated figures. Determine the effects of a dilation on the side lengths and perimeter of a polygon.	Determine if the center of dilation is on or off the line. Identify the preimage and image of a given figure and its image after a dilation. Determine the scale factor of a dilation, given the lengths of the segments.

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
	Explain why two given quadrilaterals are similar using similarity transformations.	Determine if two figures are similar by describing a sequence of similarity transformations that maps one figure onto the other. Explain using similarity transformations that similar triangles have corresponding angles congruent and corresponding sides proportional. Graph the image of a figure after a dilation with a given scale factor, *not* centered at the origin.	Determine if two figures are similar given side lengths and/or angle measures. Identify relationships about corresponding parts of dilated figures when given diagrams or similarity statements about figures. Graph the image of a figure after a dilation with a given scale factor, centered at the origin. Determine the center and/or scale factor of the dilation when given a figure and its image graphed on a set of axes.	Identify corresponding segments and angles of dilated figures.
	Prove why triangles are similar by AA~, SSS~, and SAS~, using similarity transformations.	Explain that triangles are similar by AA~, SSS~, and SAS~, using similarity transformations.	Identify why triangles are similar by AA~, SSS~, and SAS~ from stated information or a marked diagram.	

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
Prove theorems involving similarity. SRT.B	Prove theorem(s) or solve problems by using auxiliary lines in diagrams.	Provide a complete line of geometric reasoning to prove relationships between geometric figures or prove a stated geometric theorem. Apply similarity theorems about triangles to explain a geometric relationship.	Provide a partial line of geometric reasoning in an effort to prove a specific geometric statement. Apply similarity theorems about triangles to justify a geometric relationship.	Provide a correct geometric statement pertaining to the given geometric information. Identify corresponding parts with two similar triangles.
		Apply geometric relationships between congruent triangles to solve problems algebraically. Apply geometric relationships between similar triangles to solve problems algebraically. (Ex: altitude drawn to the hypotenuse of a right triangle theorem.)	Apply geometric relationships between congruent triangles to solve problems numerically. Apply geometric relationships between similar triangles to solve problems numerically. (Ex: apply triangle proportionality theorems or determine the length of a segment of a median given the centroid and the length of the median.)	Identify angle pair relationships when parallel lines are cut by a transversal.

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
Define trigonometric ratios and solve problems involving right triangles. SRT.C	Explain why the sine, cosine, and tangent ratios of corresponding angles in similar right triangles are equivalent.	Identify ratios representing the sine, cosine, and tangent of a given angle of similar right triangles.	Identify ratios representing the sine, cosine, and tangent of a given angle of a single right triangle.	Identify the hypotenuse and the opposite and adjacent sides of a referenced acute angle in a right triangle.
		Determine equivalent ratios or angle measures in similar right triangles using the relationship between the sine and cosine of complementary angles. Explain how the relationship between the sine and cosine of complementary angles can be used to determine a measurement in a right triangle. Write and solve cofunction equations. (Ex: $\sin(2x+4) = \cos(46)$ when the acute angles sum to 90°, $(2x+4)+(46)=90$.)	Identify the relationship between the sine and cosine of complementary angles in a right triangle.	Determine the complement of an acute angle.
	Solve for missing side lengths and/or angle measures of right triangles using multiple sine, cosine, tangent equations and/or the properties of special right triangles in a real-world scenario where creating a diagram may be necessary.	Solve for a missing side length or angle measure of a right triangle using sine, cosine, or tangent, or using a special right triangle in a real-world scenario where creating a diagram may be necessary.	Write a relevant trigonometric equation when given a diagram. Determine the remaining side lengths of special right triangles when given a leg of a 45-45-90 triangle or the shorter leg or hypotenuse of a 30-60-90 triangle.	Solve for missing side lengths of right triangles using the Pythagorean Theorem. Draw a diagram that models a real-world problem using one right triangle.

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
Apply Trigonometry to general triangles. (Triangles are not plotted on the coordinate plane.) SRT.D	*Determine a missing side or angle of a non-right triangle given the area of the triangle, considering both acute and obtuse angles.	Justify the formula $A = \frac{1}{2}ab\sin(C)$ to find the area of any triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side. Determine a missing side of a non-right triangle, given the area of the triangle, an angle, and a side adjacent to the angle. Determine a missing acute angle of a non-right triangle, given the area of the triangle and the two sides forming the desired acute angle.	Use $A = \frac{1}{2}ab\sin(C)$ to determine the area of a non-right triangle when angle *C* and sides *a* and *b* are given.	

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Understand and apply theorems about circles. C.A		Prove that all circles are similar by describing a sequence of transformations that maps one circle onto another.	Determine the scale factor of a dilation when the numerical lengths of the radii of the circles are not given. (Ex: radii are $\overline{OA}$ and $\overline{OB}$.)	Determine the scale factor of a dilation given the numerical lengths of the radii of circles. (Ex: radii are 2 and 6.)
	Explain relationships between arcs, angles, and segments pertaining to circles. Prove theorem(s) or solve problems by using auxiliary lines in diagrams using circle theorems.	Apply relationships among arcs, chords, radii, secants, and tangents of a circle to solve problems algebraically. Provide a complete line of geometric reasoning to prove relationships between geometric figures or prove a stated geometric theorem using circle theorems.	Apply relationships among arcs, chords, radii, secants, and tangents of a circle to solve problems numerically. Provide a partial line of geometric reasoning in an effort to prove a specific geometric statement using circle theorems.	Identify arcs, angles, radii, diameters, chords, secants, tangents, and the center of a circle. Provide a correct geometric statement pertaining to the given geometric information using circle theorems.

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Find arc lengths and area of sectors of circles. **C.B**	*Derive a formula for the area of a sector.	Determine the area of a sector, degree measure of the central angle, or length of the radius of a circle using proportionality when given the other two measurements.	Determine the area of a sector, using the degree measure of a central angle and the length of the radius or diameter.	Identify the sector of a circle.
	*Derive a formula for arc length.	Determine the arc length, degree measure of the central angle, or length of the radius of a circle using proportionality when given the other two measurements.	Determine the length of an arc, using the degree measure of a central angle and the length of the radius or diameter.	
	Determine the degree measure of the central angle and/or the radius when given both the area of the sector and arc length.			

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Translate between the geometric description and the equation of a conic section. **GPE.A**	*Derive the equation of a circle given the coordinates of the center and the length of the radius using the Pythagorean Theorem.	Determine the coordinates of the center and length of the radius of the circle using the method of completing the square. Write the equation of a circle given two endpoints of a diameter of the circle. Graph a circle when given the equation of the circle.	Determine the coordinates of the center and length of the radius of the circle when given the equation of a circle in center-radius form. Write an equation of a circle, given the coordinates of the center and length of the radius or the graph of the circle. Graph a circle when given the equation of the circle in center-radius form.	Determine the coordinates of the center and length of the radius of the circle when given the graph of a circle. Graph a circle given the coordinates of the center and length of the radius.

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Use coordinates to prove simple geometric theorems algebraically. **GPE.B**	* Create a complete line of geometric reasoning to prove geometric figures and relationships or prove a stated geometric theorem when using coordinate geometry and given variable coordinates. (Ex: given $A(0,0)$, $B(a,b)$, and $C(2a,0)$, prove $\triangle ABC$ is an isosceles triangle but not a right triangle.)	Create a complete line of geometric reasoning to prove geometric figures and relationships or prove a stated geometric theorem when using coordinate geometry. (Ex: given $A(0,4)$, $B(3,8)$, $C(8,3)$, and $D(5,-1)$, prove $ABCD$ is a parallelogram and not a rectangle.)	Create a partial line of geometric reasoning in an effort to prove a specific geometric statement when using coordinate geometry. (Ex: determine midpoints, slopes, and/or lengths of line segments.)	Provide a correct geometric statement pertaining to the given geometric information.
	Determine an equation of the perpendicular bisector of a non-horizontal or non-vertical segment when given the coordinates of the endpoints of a segment.	Determine if lines are parallel, perpendicular, or neither, based on their slopes.	Determine the slope of a line when given a pair of coordinates.	Identify pairs of lines which are parallel when graphed on the coordinate plane.
		Solve geometric problems when applying properties of parallel and perpendicular lines on the coordinate plane. (Ex: write an equation of a line that is parallel/ perpendicular to a given line and passes through a given point.)		Identify the slope of a line when given an equation or graph.

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Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
	Determine the endpoint of a directed line segment, given the other endpoint and the point that partitions the segment in a given ratio.	Determine the point on a directed line segment that partitions the segment in a given ratio.	Determine the midpoint of a segment to justify the segment is divided into a 1:1 ratio. Determine the point on a horizontal or vertical directed line segment that partitions the segment in a given ratio on the coordinate plane.	
		Compute perimeters of polygons using coordinates. Compute areas of polygons by utilizing the areas of triangles and rectangles using coordinate geometry. Solve modeling problems involving perimeter and area using coordinate geometry.	Determine the length of a segment using the distance formula.	Compute areas of triangles and trapezoids with horizontal and vertical bases and heights on the coordinate plane.

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
Explain volume formulas and use them to solve problems. **GMD.A**		Provide informal arguments for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone.	Determine the volume of a pyramid or a hemisphere.	Determine the circumference and area of circles. Determine the volume of a cylinder, cone, prism, or sphere.
		Determine the radius or another dimension when given the volume, area, circumference, or slant height. Determine the volume of three-dimensional objects composed of two or more solids. Solve real-world problems using volume formulas for cylinders, prisms, pyramids, cones, spheres, and hemispheres.		

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
Visualize relationships between two-dimensional and three-dimensional objects. GMD.B	Identify the shapes of plane sections of three-dimensional objects composed of two or more solids.	Identify the shapes of plane sections of three-dimensional objects that are not parallel and not perpendicular to the base.	Identify the two-dimensional shape of the plane section that is perpendicular to the base when given a prism, cylinder, cone, or pyramid.	Identify the two-dimensional shape of the plane section that is parallel to the base when given a prism, cylinder, cone, or pyramid.
		Identify the two-dimensional plane section formed when a plane intersects a sphere or hemisphere.	Identify the two-dimensional plane section formed when a plane intersects a sphere.	
	Identify, describe, and determine the dimensions of three-dimensional composite objects composed of two or more cones, cylinders, spheres, and/or hemispheres formed by continuously rotating a two-dimensional shape about a line or line segment. (Ex: continuously rotate a right trapezoid about its longer base, creating a cone and cylinder sharing the same base.)	Identify and describe a three-dimensional object and its dimensions generated by continuously rotating a two-dimensional shape about a line or line segment. (Ex: continuously rotate an equilateral triangle about one of its altitudes.)	Identify a three-dimensional object generated by continuously rotating a rectangle or square about one of its sides, or a right triangle about one of its legs.	

Cluster	Performance Level 5	Performance Level 4	Performance Level 3	Performance Level 2
Apply geometric concepts in modeling situations. **MG.A**	Develop an appropriate geometric model when given a real-world scenario.	Model real-world scenarios using three-dimensional objects, their measures, and their properties.	Identify the three-dimensional objects composed of two or more solids. (Ex: a snow-cone is composed of a hemisphere and cone.)	Describe a three-dimensional object, given its diagram. (Ex: a roll of candy is a cylinder.)
		Apply concepts of density based on area and volume of figures in modeling situations.	Determine one of the following given the other two: density, mass, or volume. Determine one of the following given the other two: population, area, or the population density. Convert between two units of measure including appropriate rates of measure. (Ex: determine a cost based on a price per cubic foot.)	Convert between two units of measure (does not include rates).
	Create a diagram to model a design scenario and perform calculations based on geometric relationships to draw conclusions.	Determine a solution by performing calculations based on geometric relationships given a design scenario. (Ex: determine a volume and use a unit rate to determine a cost.) Solve problems using given constraints. (Ex: determine the number of items that can fit on a shelf with given dimensions.)	Identify an algebraic expression or equation that represents a geometric relationship between variables. (Ex: write an equation to represent the volume of an object.) Write an expression to represent geometric components algebraically when given a description.	Identify the variables in a design scenario and select those that represent essential features given a diagram. Write an expression to represent geometric components algebraically when given a diagram. (Ex: the perimeter of a pickleball court, given a labeled diagram.)