Traditional Pathway Year 2 Geometry
DCAS Aligned to Common Core State Standards

The following document shows the alignment of the Delaware Comprehensive Assessment System (DCAS) to the Delaware Common Core State Standards (CCSS), as reflected on the computer-adaptive test for Geometry. To respect the intent of the CCSS, all standards are represented in either the traditional or integrated pathway documents. Therefore, all standards should be taught in grades 9 through 11 to ensure continuity of learning.

The standards that are identified in the Geometry document are specific to this course. Where there are gaps in numbering of the standards, please refer to the Overview of the Pathway document to see the vertical alignment within that CCSS domain.

Number and Quantity
9-12.N.RN – The Real Number System Domain
• **Extend the properties of exponents to rational exponents.**
N.RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.
9-12.N.Q – Quantities* Domain
• **Reason quantitatively and use units to solve problems.**
N.Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
N.Q.2 Define appropriate quantities for the purpose of descriptive modeling.
N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
9-12.N.CN – The Complex Number System Domain
• **Perform arithmetic operations with complex numbers.**
N.CN.1 Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.
N.CN.2 Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
• **Use complex numbers in polynomial identities and equations.**
N.CN.7 Solve quadratic equations with real coefficients that have complex solutions.

9-12.N.VM – Vector and Matrix Quantities Domain
• **Perform operations on matrices and use matrices in applications.**
N.VM.6 (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.
N.VM.7 (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.
N.VM.8 (+) Add, subtract, and multiply matrices of appropriate dimensions.
N.VM.10 (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.
N.VM.11 (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.
N.VM.12 (+) Work with *2* × *2* matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Algebra
9-12.A.APR – Arithmetic with Polynomials and Rational Expressions Domain
• **Understand the relationship between zeros and factors of polynomials.**
A.APR.2 Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number a, the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$.
• **Use polynomial identities to solve problems.**
A.APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.
• **Rewrite rational expressions.**
A.APR.6 Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or, for the more complicated examples, a computer algebra system.
9-12.A.CED – Creating Equations* Domain
• **Create equations that describe numbers or relationships.**
A.CED.1 Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law $V = IR$ to highlight resistance R.*
9-12.A.REI – Reasoning with Equations and Inequalities Domain
• **Understand solving equations as a process of reasoning and explain the reasoning.**
A.REI.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
• **Solve equations and inequalities in one variable.**
A.REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
A.REI.4 Solve quadratic equations in one variable.
A.REI.4b Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.
• **Solve systems of equations.**
A.REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. *For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$.*

Functions
9-12.F.IF – Interpreting Functions Domain
• **Understand the concept of a function and use function notation.**
F.IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
• **Interpret functions that arise in applications in terms of the context.**
F.IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.**
• **Analyze functions using different representations.** ▪ *Geometry Clarification: Exponential, quadratic, absolute value, step, piecewise-defined*
F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.*
F.IF.7a Graph quadratic functions and show intercepts, maxima, and minima.
F.IF.7b Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
F.IF.7e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
F.IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*
9-12.F.BF – Building Functions Domain
• **Build a function that models a relationship between two quantities**
F.BF.1 Write a function that describes a relationship between two quantities.*
F.BF.1a Determine an explicit expression, a recursive process, or steps for calculation from a context.
F.BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*
• **Build new functions from existing functions.** ▪ *Standard Clarification: Quadratic and absolute value*
F.BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. *Include recognizing even and odd functions from their graphs and algebraic expressions for them.*
F.BF.4 Find inverse functions.
F.BF.4a Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. *For example,* $f(x) = 2x^3$ *or* $f(x) = (x + 1)/(x - 1)$ *for* $x \neq 1$.

9-12.F.LE – Linear, Quadratic, and Exponential Models Domain
• **Construct and compare linear, quadratic, and exponential models and solve problems.**
F.LE.4 For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.
9-12.F.TF – Trigonometric Functions Domain
• **Extend the domain of trigonometric functions using the unit circle.**
F.TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.
F.TF.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.
• **Model periodic phenomena with trigonometric functions.**
F.TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*
• **Prove and apply trigonometric identities.**
F.TF.8 Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.

Geometry
9-12.G.CO – Congruence Domain
• **Experiment with transformations in the plane.**
G.CO.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
G.CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).
G.CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.
G.CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
G.CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
• **Understand congruence in terms of rigid motions.** ▪ *Standard Clarification: Build on rigid motions as a familiar starting point for development of concept of geometric proof*
G.CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.
G.CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.
G.CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.
• **Prove geometric theorems.** ▪ *Standard Clarification: Focus on validity of underlying reasoning while using variety of ways of writing proofs*
G.CO.9 Prove theorems about lines and angles. *Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.*
G.CO.10 Prove theorems about triangles. *Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.*
G.CO.11 Prove theorems about parallelograms. *Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.*
• **Make geometric constructions.** ▪ *Standard Clarification: Formalize and explain processes*
G.CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). *Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.*
G.CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

9-12.G.SRT – Similarity, Right Triangles, and Trigonometry Domain
• **Understand similarity in terms of similarity transformations.**
G.SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor
G.SRT.1a A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.
G.SRT.1b The dilation of a line segment is longer or shorter in the ratio given by the scale factor.
G.SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.
G.SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.
• **Prove theorems involving similarity.**
G.SRT.4 Prove theorems about triangles. *Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.*
G.SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
• **Define trigonometric ratios and solve problems involving right triangles.**
G.SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
G.SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.
G.SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*
• **Apply trigonometry to general triangles**
G.SRT.9 (+) Derive the formula $A = 1/2\ ab \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.
G.SRT.10 (+) Prove the Laws of Sines and Cosines and use them to solve problems.
G.SRT.11 (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

9-12.G.C – Circles Domain
• **Understand and apply theorems about circles.**
G.C.1 Prove that all circles are similar.
G.C.2 Identify and describe relationships among inscribed angles, radii, and chords. *Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.*
G.C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.
• **Find arc lengths and areas of sectors of circles.** ▪ *Standard Clarification: Radian introduced only as unit of measure*
G.C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.
9-12.G.GPE – Expressing Geometric Properties with Equations Domain
• **Translate between the geometric description and the equation for a conic section.**
G.GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.
G.GPE.2 Derive the equation of a parabola given a focus and directrix.
• **Use coordinates to prove simple geometric theorems algebraically.** ▪ *Standard Clarification: Include distance formula; relate to Pythagorean theorem*
G.GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2).
G.GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).
G.GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
G.GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*
9-12.G.GMD – Geometric Measurement and Dimension Domain
• **Explain volume formulas and use them to solve problems.**
G.GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. *Use dissection arguments, Cavalieri's principle, and informal limit arguments.*
G.GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*
• **Visualize relationships between two-dimensional and three-dimensional objects**
G.GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

9-12.G.MG – Modeling with Geometry Domain
• **Apply geometric concepts in modeling situations.**
G.MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*
G.MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*
G.MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

Statistics and Probability
9-12.S.ID – Interpreting Categorical and Quantitative Data Domain
• **Summarize, represent, and interpret data on a single count or measurement variable.**
S.ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.
9-12.S.IC – Making Inferences and Justifying Conclusions Domain
• **Understand and evaluate random processes underlying statistical experiments.**
S.IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
S.IC.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. *For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*
• **Make inferences and justify conclusions from sample surveys, experiments, and observational studies.**
S.IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
S.IC.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
S.IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
S.IC.6 Evaluate reports based on data.
9-12.S.CP – Conditional Probability and the Rules of Probability Domain
• **Understand independence and conditional probability and use them to interpret data**
S.CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").
S.CP.2 Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
S.CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. *For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*
• **Use the rules of probability to compute probabilities of compound events in a uniform probability model.**
S.CP.9 (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

* Modeling is best interpreted not as a collection of isolated topics but in relation to other standards. Making mathematical models is a Standard for Mathematical Practice, and specific modeling standards appear throughout the high school standards indicated by a star symbol (*).