Indiana Department of Education

Geometry Math Content Connectors

Geometry

PROCESS STANDARDS FOR MATHEMATICS

The Process Standards demonstrate the ways in which students should develop conceptual understanding of mathematical content, and the ways in which students should synthesize and apply mathematical skills.

PROCESS STANDARDS FOR MATHEMATICS	
PS.1: Make sense of problems and persevere in solving them.	Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway, rather than simply jumping into a solution attempt. They consider analogous problems and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” and "Is my answer reasonable?" They understand the approaches of others to solving complex problems and identify correspondences between different approaches. Mathematically proficient students understand how mathematical ideas interconnect and build on one another to produce a coherent whole.
PS.2: Reason abstractly and quantitatively.	Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

PS.3: Construct viable arguments and critique the reasoning of others.	Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They analyze situations by breaking them into cases and recognize and use counterexamples. They organize their mathematical thinking, justify their conclusions and communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. They justify whether a given statement is true always, sometimes, or never. Mathematically proficient students participate and collaborate in a mathematics community. They listen to or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

PS.4: Model with mathematics.	Mathematically proficient students apply the mathematics they know to solve problems arising in everyday life, society, and the workplace using a variety of appropriate strategies. They create and use a variety of representations to solve problems and to organize and communicate mathematical ideas. Mathematically proficient students apply what they know and are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.
PS.5: Use appropriate tools strategically.	Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Mathematically proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. Mathematically proficient students identify relevant external mathematical resources, such as digital content, and use them to pose or solve problems. They use technological tools to explore and deepen their understanding of concepts and to support the development of learning mathematics. They use technology to contribute to concept development, simulation, representation, reasoning, communication and problem solving.

PS.6: Attend to precision.	Mathematically proficient students communicate precisely to others. They use clear definitions, including correct mathematical language, in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They express solutions clearly and logically by using the appropriate mathematical terms and notation. They specify units of measure and label axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently and check the validity of their results in the context of the problem. They express numerical answers with a degree of precision appropriate for the problem context.
PS.7: Look for and make use of structure.	Mathematically proficient students look closely to discern a pattern or structure. They step back for an overview and shift perspective. They recognize and use properties of operations and equality. They organize and classify geometric shapes based on their attributes. They see expressions, equations, and geometric figures as single objects or as being composed of several objects.
PS.8: Look for and express regularity in repeated reasoning.	Mathematically proficient students notice if calculations are repeated and look for general methods and shortcuts. They notice regularity in mathematical problems and their work to create a rule or formula. Mathematically proficient students maintain oversight of the process, while attending to the details as they solve a problem. They continually evaluate the reasonableness of their intermediate results.

GEOMETRY

The Mathematics standards for Geometry are supplemented by the Process Standards for Mathematics.

The Mathematics standards for Geometry are made up of five strands: Logic and Proofs; Points, Lines, Angles, and Planes; Triangles; Quadrilaterals and Other Polygons; Circles; Transformations; and Three-dimensional Solids. The skills listed in each strand indicate what students should know and be able to do in Geometry.

LOGIC AND PROOFS

Indiana Academic Standards	Content Connectors
G.LP.1: Understand and describe the structure of and relationships within an axiomatic system (undefined terms, definitions, axioms and postulates, methods of reasoning, and theorems). Understand the differences among supporting evidence, counterexamples, and actual proofs.	**G.LP.1.a.1**: Utilize a definition, postulate, or theorem to support a method of reasoning.

G.LP.2: Know precise definitions for angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, and plane. Use standard geometric notation.	**G.LP.2.a.1:** Identify an angle, circle, point, plane, and various lines.
G.LP.3: State, use, and examine the validity of the converse, inverse, and contrapositive of conditional ("if – then") and bi-conditional ("if and only if") statements.	**G.LP.3.a.1**: Identify the converse, inverse, and contraposition of conditional and bi-conditional statements.
G.LP.4: Develop geometric proofs, including direct proofs, indirect proofs, proofs by contradiction and proofs involving coordinate geometry, using twocolumn, paragraphs, and flow charts formats.	**G.LP.4.a.1**: Utilize definitions, postulates, and theorems to develop a simple geometric proof.

POINTS, LINES, ANGLES, AND PLANES

Indiana Academic Standards	Content Connectors
G.PL.1: Identify, justify, and apply properties of planes.	**G.PL.1.a.1:** Identify properties of planes.
G.PL.2: Describe the intersection of two or more geometric figures in the same plane.	**G.PL.2.a.1**: Identify the intersection of two or more geometric figures in the same plane.
G.PL.3: Prove and apply theorems about lines and angles, including the following: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent, alternate exterior angles are congruent, and corresponding angles are congruent; when a transversal crosses parallel lines, same side interior angles are supplementary; and points on a perpendicular bisector of a line segment are exactly those equidistant from the endpoints of the segment.	**G.PL.3.a.1:** Identify angle relationships when a transversal crosses parallel lines.
G.PL.4: Know that parallel lines have the same slope and perpendicular lines have opposite reciprocal slopes. Determine if a pair of lines are parallel, perpendicular, or neither by comparing the slopes in coordinate graphs and in equations. Find the equation of a line, passing through a given point that is parallel or perpendicular to a given line.	**G.PL.4.a.1**: Identify lines as parallel or perpendicular based on whether they have the same slope or opposite reciprocal slope.

G.PL.5: Explain and justify the process used to construct, with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.), congruent segments and angles, angle bisectors, perpendicular bisectors, altitudes, medians, and parallel and perpendicular lines.	**G.PL.5.a.1:** Construct congruent segments and angles, bisectors, parallel and perpendicular lines.

TRIANGLES

Indiana Academic Standards	Content Connectors
G.T.1: Prove and apply theorems about triangles, including the following: 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; a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem, using triangle similarity; and the isosceles triangle theorem and its converse.	**G.T.1.a.1**: Use triangle theorems and definitions to find angle measures and segment lengths.
G.T.2: Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.	**G.T.2.a.1:** Determine a triangle congruence theorem used to prove two given triangles are congruent.
G.T.3: Explain and justify the process used to construct congruent triangles with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).	
G.T.4: Given two triangles, 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, and to establish the AA criterion for two triangles to be similar.	**G.T.4.a.1:** Given two triangles, determine if they are similar based on the triangle similarity theorems (AA, SAS, SSS).

G.T.5: Use properties of congruent and similar triangles to solve real-world and mathematical problems involving sides, perimeters, and areas of triangles.	**G.T.5.a.1**: Given real-world problems, find various measures of triangles using properties of congruence and similarity.
G.T.6: Prove and apply the inequality theorems, including the following: triangle inequality, inequality in one triangle, and the hinge theorem and its converse.	**G.T.6.a.1**: Determine if a triangle can be constructed from three given side lengths.
	G.T.6.a.2: Order side lengths based on the angle measures, and angle measures based on side lengths.
	G.T.6.a.3: Use the Hinge Theorem and its converse to find a side length or an angle measure.
G.T.7: State and apply the relationships that exist when the altitude is drawn to the hypotenuse of a right triangle. Understand and use the geometric mean to solve for missing parts of triangles.	**G.T.7.a.1**: Identify three similar triangles in a given diagram when the altitude is drawn to the hypotenuse.
G.T.8: Develop the distance formula using the Pythagorean Theorem. Find the lengths and midpoints of line segments in one- or twodimensional coordinate systems. Find measures of the sides of polygons in the coordinate plane; apply this technique to compute the perimeters and areas of polygons in real-world and mathematical problems.	**G.T.8.a.1**: Find a segment length using the distance formula.
	G.T.8.a.2: Find the midpoint of a line segment.
	G.T.8.a.3: Apply the distance formula and midpoint formula in a real-world problem.
G.T.9: 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.T.9.a.1**: Recognize trigonometric ratios for acute angles given side ratios of right triangles.
G.T.10: Use trigonometric ratios (sine, cosine and tangent) and the Pythagorean Theorem to solve realworld and mathematical problems involving right triangles.	**G.T.10.a.1:** Find acute angle measures and side lengths in a right triangle using trigonometric ratios.
G.T.11: Use special right triangles (30° - 60° and 45° - 45°) to solve real-world and mathematical problems.	**G.T.11.a.1**: Apply special right triangles to find a segment length.

	G.T.11.a.2: Apply special right triangles to find angle measures of a right triangle.

QUADRILATERALS AND OTHER POLYGONS

G.QP.1: Prove and apply theorems about parallelograms, including the following: opposite sides are congruent; opposite angles are congruent; the diagonals of a parallelogram bisect each other; and rectangles are parallelograms with congruent diagonals.	**G.QP.1.a.1**: Identify properties of parallelograms.
G.QP.2: Prove that given quadrilaterals are parallelograms, rhombuses, rectangles, squares or trapezoids. Include coordinate proofs of quadrilaterals in the coordinate plane.	**G.QP.2.a.1**: Classify a quadrilateral based on its properties.
G.QP.3: Find measures of interior and exterior angles of polygons. Explain and justify the method used.	**G.QP.3.a.1**: Find measures of interior and exterior angles of polygons.
G.QP.4: Identify types of symmetry of polygons, including line, point, rotational, and selfcongruencies.	**G.QP.4.a.1**: Determine whether a polygon has line symmetry or rotational symmetry.
G.QP.5: Deduce formulas relating lengths and sides, perimeters, and areas of regular polygons. Understand how limiting cases of such formulas lead to expressions for the circumference and the area of a circle.	

CIRCLES

G.CI.1: Define, identify and use relationships among the following: radius, diameter, arc, measure of an arc, chord, secant, tangent, and congruent concentric circles.	**G.CI.1.a.1**: Identify the following attributes of a circle: radius, diameter, arc, measure of an arc, chord, secant, tangent, and congruent concentric circles.
G.CI.2: Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius; derive the formula for the area of a sector.	**G.CI.2.a.1**: Apply the formula for area of a sector.

G.CI.3: Identify and describe relationships among inscribed angles, radii, and chords, including the following: the relationship that exists between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; and the radius of a circle is perpendicular to a tangent where the radius intersects the circle.	**G.CI.3.a.1**: Identify inscribed, circumscribed, and central angles.
G.CI.4: Solve real-world and other mathematical problems that involve finding measures of circumference, areas of circles and sectors, and arc lengths and related angles (central, inscribed, and intersections of secants and tangents).	**G.CI.4.a.1**: Apply the formula to find the measure of circumference, area of circles, and related angles.
G.CI.5: Construct a circle that passes through three given points not on a line and justify the process used.	**G.CI.5.a.1:** Construct a circle that passes through three given points not on a line.
G.CI.6: Construct a tangent line to a circle through a point on the circle, and construct a tangent line from a point outside a given circle to the circle; justify the process used for each construction.	**G.CI.6.a.1**: Construct a tangent line to a circle through a point on the circle, and construct a tangent line from a point outside a given circle to the circle.
G.CI.7: Construct the inscribed and circumscribed circles of a triangle with or without technology, and prove properties of angles for a quadrilateral inscribed in a circle.	**G.CI.7.a.1**: Construct the inscribed and circumscribed circles of a triangle.
	G**.CI.7.a.2**: Find angle measures using properties of a quadrilateral inscribed in a circle.

TRANSFORMATIONS

G.TR.1: Use geometric descriptions of rigid motions to transform figures and to predict and describe the results of translations, reflections and rotations on a	**G.TR.1.a.1**: Know the definition of rigid motions.
given figure. Describe a motion or series of motions that will show two shapes are congruent.	**G.TR.1.a.2:** Describe a series of rigid transformations.
G.TR.2: Understand 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. Verify experimentally the properties of dilations given by a center and a scale factor. Understand the dilation of a line segment is longer or shorter in the ratio given by the scale factor.	**G.TR.2.a.1**: Given a scale factor identify the dilation as an enlargement or a reduction.
	G.TR.2.a.2: Given two similar figures, find the scale factor.

THREE-DIMENSIONAL SOLIDS

G.TS.1: Describe relationships between the faces, edges, and vertices of three-dimensional solids. Create a net for a given three-dimensional solid. Describe the three-dimensional solid that can be made from a given net (or pattern).	**G.TS.1.a.1**: Apply Euler's Theorem to find the number of faces, edges, or vertices of a threedimensional solid.
	G.TS.1.a.2: Describe the three-dimensional solid that can be made from a given net.
G.TS.2: Describe symmetries of three-dimensional solids.	**G.TS.2.a.1**: Determine the number of symmetries of a given three-dimensional solid.
G.TS.3: Know properties of congruent and similar solids, including prisms, regular pyramids, cylinders, cones, and spheres; solve problems involving congruent and similar solids.	**G.TS.3.a.1**: Explain why two solids are congruent or similar.
G.TS.4: Describe sets of points on spheres, including chords, tangents, and great circles.	**G.TS.4.a.1**: Identify a set of points on a sphere as a chord, tangent, or great circle.
G.TS.5: Solve real-world and other mathematical problems involving volume and surface area of prisms, cylinders, cones, spheres, and pyramids, including problems that involve algebraic expressions.	**G.TS.5.a.1**: Find surface area and volume of threedimensional figures given a real-world problem.
G.TS.6: 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).	
G.TS.7: Graph points on a three-dimensional coordinate plane. Explain how the coordinates relate the point as the distance from the origin on each of the three axes.	**G.TS.7.a.1**: Graph a point on a three-dimensional coordinate plane.
G.TS.8: Determine the distance of a point to the origin on the three-dimensional coordinate plane using the distance formula.	**G.TS.8.a.1**: Using the distance formula, find the distance between the origin and a point on the threedimensional coordinate plane.

G.TS.9: Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.	**G.TS.9.a.1**: Classify the shape of the cross-section created by the intersection of a two-dimensional figure and a three-dimensional solid.