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| **HS Mathematics: Geometry – Planning Tool** | | | | | | | | | | |
| Collaborators: | | | | | Academic Year: | | | | | |
| *This planning tool can be used by collaborating teachers across a given school year or term to help insure full implementation of the Iowa Core Content Standards into their classroom instructional and assessment activities.* *Full implementation is accomplished when the district or school is able to provide evidence that an ongoing process is in place to ensure that each and every student is learning the standards and the essential concepts and skills of the Iowa Core. A school that has fully implemented the Iowa Core is engaged in an ongoing process of data gathering and analysis, decision making, identifying actions, and assessing the impact around alignment and professional development focused on content, instruction, and assessment. The school is fully engaged in a continuous improvement process that specifically targets improved student learning and performance.*  ***Effective implementation of the Iowa Core is not a simple checklist. Implementation requires that educators strategically and systematically address the knowledge and skills being taught, engage in collaboration around the use of effective instructional practices and materials and develop activities to elicit evidence of student learning that match the level of rigor called for in the standards.*** | | | | | | | | | | |
| **Mathematic Content Standard** | **Aug.** | **Sept** | **Oct.** | **Nov.** | **Dec.** | **Jan.** | **Feb.** | **Mar** | **Apr.** | **May** |
| **Congruence: Experiment with transformations in the plane** | | | | | | | | | | |
| 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.1.) (DOK 1)** |  |  |  |  |  |  |  |  |  |  |
| 1. 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.2.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself. **(G-CO.3.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.  **(G-CO.4.) (DOK 2)** |  |  |  |  |  |  |  |  |  |  |
| 1. 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. **(G-CO.5.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |

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| **Congruence: Understand congruence in terms of rigid motions** | | | | | | | | | | |
| 1. 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.6.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. 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.7.) (DOK 2,3)** |  |  |  |  |  |  |  |  |  |  |
| 1. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions. **(G-CO.8.) (DOK 2,3)** |  |  |  |  |  |  |  |  |  |  |
| **Congruence: Prove geometric theorems** | | | | | | | | | | |
| 1. 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.9.) (DOK 3)** |  |  |  |  |  |  |  |  |  |  |
| 1. 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.10.) (DOK 3)** |  |  |  |  |  |  |  |  |  |  |
| 1. 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. **(G-CO.11.) (DOK 3)** |  |  |  |  |  |  |  |  |  |  |

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| **Congruence: Make geometric constructions** | | | | | | | | | | |
| 1. 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.12.) (DOK 2)** |  |  |  |  |  |  |  |  |  |  |
| 1. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle. **(G-CO.13.) (DOK 2)** |  |  |  |  |  |  |  |  |  |  |
| **Similarity, Right Triangles, and Trigonometry: Understand similarity in terms of similarity transformations** | | | | | | | | | | |
| 1. Verify experimentally the properties of dilations given by a center and a scale factor: **(G-SRT.1.) (DOK 2)**    1. 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. |  |  |  |  |  |  |  |  |  |  |
| * 1. The dilation of a line segment is longer or shorter in the ratio given by the scale factor. |  |  |  |  |  |  |  |  |  |  |
| 1. 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.2.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar. **(G-SRT.3.) (DOK 2,3)** |  |  |  |  |  |  |  |  |  |  |
| **Similarity, Right Triangles, and Trigonometry: Prove theorems involving similarity** | | | | | | | | | | |
| 1. 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.4.) (DOK 3)** |  |  |  |  |  |  |  |  |  |  |
| 1. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures. **(G-SRT.5.) (DOK 1,2,3)** |  |  |  |  |  |  |  |  |  |  |
|  | **Aug.** | **Sept** | **Oct.** | **Nov.** | **Dec.** | **Jan.** | **Feb.** | **Mar** | **Apr.** | **May** |
| **Similarity, Right Triangles, and Trigonometry: Define trigonometric ratios and solve problems involving right triangles** | | | | | | | | | | |
| 1. 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.6.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. Explain and use the relationship between the sine and cosine of complementary angles. **(G-SRT.7.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. ★ **(G-SRT.8.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| **Similarity, Right Triangles, and Trigonometry: Apply trigonometry to general triangles** | | | | | | | | | | |
| 1. (+) 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.9.) (DOK 2,3)** |  |  |  |  |  |  |  |  |  |  |
| 1. (+) Prove the Laws of Sines and Cosines and use them to solve problems.  **(G-SRT.10.) (DOK 1,2,3)** |  |  |  |  |  |  |  |  |  |  |
| 1. (+) 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).  **(G-SRT.11.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| **Circles: Understand and apply theorems about circles** | | | | | | | | | | |
| 1. Prove that all circles are similar.  **(G-C.1.) (DOK 3)** |  |  |  |  |  |  |  |  |  |  |
| 1. 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.2.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.  **(G-C.3.) (DOK 2,3)** |  |  |  |  |  |  |  |  |  |  |
| 1. (+) Construct a tangent line from a point outside a given circle to the circle.  **(G-C.4.) (DOK 2)** |  |  |  |  |  |  |  |  |  |  |
|  | **Aug.** | **Sept** | **Oct.** | **Nov.** | **Dec.** | **Jan.** | **Feb.** | **Mar** | **Apr.** | **May** |
| **Circles: Find arc lengths and areas of sectors of circles** | | | | | | | | | | |
| 1. 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.  **(G-C.5.) (DOK 1,2,3)** |  |  |  |  |  |  |  |  |  |  |
| **Expressing Geometric Properties with Equations: Translate between the geometric description and the equation for a conic section** | | | | | | | | | | |
| 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.1.) (DOK 1,2,3)** |  |  |  |  |  |  |  |  |  |  |
| 1. Derive the equation of a parabola given a focus and directrix. **(G-GPE.2.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant. **(G-GPE.3.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| **Expressing Geometric Properties with Equations: Use coordinates to prove simple geometric theorems algebraically** | | | | | | | | | | |
| 1. 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.4.) (DOK 3)** |  |  |  |  |  |  |  |  |  |  |
| 1. 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.5.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.  **(G-GPE.6.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula**. (G-GPE.7.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |

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| **Geometric Measurement and Dimension: Explain volume formulas and use them to solve problems** | | | | | | | | | | |
| 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.1.) (DOK 2,3)** |  |  |  |  |  |  |  |  |  |  |
| 1. (+) Give an informal argument using Cavalieri’s principle for the formulas for the volume of a sphere and other solid figures. **(G-GMD.2.) (DOK 2,3)** |  |  |  |  |  |  |  |  |  |  |
| 1. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.  **(G-GMD.3.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| **Geometric Measurement and Dimension: Visualize relationships between two-dimensional and three-dimensional objects** | | | | | | | | | | |
| IA.7.Plot points in three-dimensions. **(DOK 1)** |  |  |  |  |  |  |  |  |  |  |
| 1. 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-GMD.4.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| **Modeling With Geometry: Apply geometric concepts in modeling situations** | | | | | | | | | | |
| 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.1.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).★ **(G-MG.2.) (DOK 1,2)** |  |  |  |  |  |  |  |  |  |  |
| 1. 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-MG.3.) (DOK 2,3,4)** |  |  |  |  |  |  |  |  |  |  |
| **(IA) Use diagrams consisting of vertices and edges (vertex-edge graphs) to model and solve problems related to networks.** | | | | | | | | | | |
| IA.8.Understand, analyze, evaluate, and apply vertex-edge graphs to model and solve problems related to paths, circuits, networks, and relationships among a finite number of elements, in real-world and abstract settings.★ **(DOK 2,3)** |  |  |  |  |  |  |  |  |  |  |
|  | **Aug.** | **Sept** | **Oct.** | **Nov.** | **Dec.** | **Jan.** | **Feb.** | **Mar** | **Apr.** | **May** |
| IA.9.Model and solve problems using at least two of the following fundamental graph topics and models: Euler paths and circuits, Hamilton paths and circuits, the traveling salesman problem (TSP), minimum spanning trees, critical paths, vertex coloring.★ **(DOK 2,3)** |  |  |  |  |  |  |  |  |  |  |
| IA.10.Compare and contrast vertex-edge graph topics and models in terms of:★ properties, algorithms, optimization, and types of problems that can be solved **(DOK 2,3)** |  |  |  |  |  |  |  |  |  |  |

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| **Mathematics Depth-Of-Knowledge Definitions - Mathematics** |

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| *Level 1 (Recall of a fact or information procedure)* includes the recall of information such as a fact, definition, term, or a simple procedure, as well as performing a simple algorithm or applying a formula. That is, in mathematics a one-step, well-defined, and straight algorithmic procedure should be included at this lowest level. Other key words that signify a Level 1 include “identify,” “recall,” “recognize,” “use,” and “measure.” Verbs such as “describe” and “explain” could be classified at different levels depending on what is to be described and explained. Examples: |

* Recall or recognize a fact, term or property
* Represent in words, pictures or symbols in a math object or relationship
* Perform routine procedure like measuring

Level 2 (Basic Reasoning: Use information or conceptual knowledge, two or more steps) includes the engagement of some mental processing beyond a habitual response. A Level 2 assessment item requires students to make some decisions as to how to approach the problem or activity, whereas Level 1 requires students to demonstrate a rote response, perform a well-known algorithm, follow a set procedure (like a recipe), or perform a clearly defined series of steps. Keywords that generally distinguish a Level 2 item include “classify,” “organize,” ”estimate,” “make observations,” “collect and display data,” and “compare data.” These actions imply more than one step. For example, to compare data requires first identifying characteristics of the objects or phenomenon and then grouping or ordering the objects.

Some action verbs, such as “explain,” “describe,” or “interpret” could be classified at different levels depending on the object of the action. For example, if an item required students to explain how light affects mass by indicating there is a relationship between light and heat, this is considered a Level 2. Other Level 2 activities include explaining the purpose and use of experimental procedures; carrying out experimental procedures; making observations and collecting data; classifying, organizing, and comparing data; and organizing and displaying data in tables, graphs, and charts.

* Specify and explain relationships between facts, terms, properties or operations
* Select procedure according to criteria and perform it
* Solve routine multiple-step problems

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| *Level 3 (Complex Reasoning: Requires reasoning, developing a plan or a sequence of steps, working with some complexity, and considering more than one possible approach and answer)* requires reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. In most instances, requiring students to explain their thinking is a Level 3. Activities that require students to make conjectures are also at this level. The cognitive demands at Level 3 are complex and abstract. The complexity does **not** result from the fact that there are multiple answers, a possibility for both Levels 1 and 2, but because the task requires more demanding reasoning. An activity, however, that has more than one possible answer and requires students to justify the response they give would most likely be a Level 3. Other Level 3 activities include drawing conclusions from observations; citing evidence and developing a logical argument for concepts; explaining phenomena in terms of concepts; and using concepts to solve problems. |

* Analyze similarities and differences between procedures
* Formulate original problem given situation
* Formulate mathematical model for complex situation

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| *Level 4 (Extended Reasoning: Requires an investigation, time to think and process multiple conditions of the problem)* requires complex reasoning, planning, developing, and thinking most likely over an extended period of time. The extended time period is **not** a distinguishing factor if the required work is only repetitive and does **not** require applying significant conceptual understanding and higher-order thinking. For example, if a student has to take the water temperature from a river each day for a month and then construct a graph, this would be classified as a Level 2. However, if the student is to conduct a river study that requires taking into consideration a number of variables, this would be a Level 4. At Level 4, the cognitive demands of the task should be high and the work should be very complex. Students should be required to make several connections—relate ideas within the content area or among content areas—and have to select one approach among many alternatives on how the situation should be solved, in order to be at this highest level. Level 4 activities include designing and conducting experiments; making connections between a finding and related concepts and phenomena; combining and synthesizing ideas into new concepts; and critiquing experimental designs. |

* Apply mathematical model to illuminate a problem, situation
* Conduct a project that specifies a problem, identifies solution paths, solves the problem, and reports results
* Design a mathematical model to inform and solve a practical or abstract situation