Honors Geometry

UNIT 1: FOUNDATIONS OF GEOMETRY

ESSENTIAL QUESTION	BIG IDEAS
How do we communicate geometric concepts?	Students will distinguish and apply the vocabulary and notation of key foundational geometric terms. Students will construct arguments about lines and angles. Students will engineer constructions using a variety of tools. Students will use algebra to construct arguments to justify geometric theorems.

GUIDING QUESTIONS

Content and Process

- What angle pairs can or cannot be adjacent? **G.CO.7.**
- How do we differentiate between segments, lines, and rays? **G.CO.7., G.CO.11**
- What angle relationships exist when two lines intersect? **G.CO.7.**
- What is the relationship between the two lines formed by connecting the points on a bisector of a line segment to each of the segment's endpoints? **G.CO.7.**
- How can congruent angles and segments be constructed? **G.CO.11.**
- How can angle and segment bisectors be constructed? **G.CO.11.**
- How can parallel lines, perpendicular lines, and perpendicular bisectors be constructed? **G.CO.11.**
- How are slope and the distance between two points on the coordinate plane used to prove the midpoint formula? **G.GPE.6**
- How is the midpoint formula used to find the midpoint of a segment? **G.GPE.6**
- When given two lines, how do you determine if the lines are parallel or perpendicular? **G.GPE.7**
- How can you write the equation of parallel and perpendicular lines given a line and a point not on the line? **G.GPE.7**

Reflective

- Why is it important for me to use proper geometric vocabulary and appropriate notation to communicate effectively?
- How can I explain that a segment has a bisector and a line does not?
- How can I show the relationship between the Pythagorean Theorem and the distance formula?
- How can I use parallel and perpendicular lines and the distance formula to classify figures?
- How can I explain the relationship between slope, midpoint, and distance to a friend?

FOCUS STANDARDS

Standards of Mathematical Practice

MP.5 Use appropriate tools strategically.

MP.6 Attend to precision.

Content Standards

G.CO.7 (9/10) Construct arguments about lines and angles using theorems. 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. (Building upon standard in 8th grade Geometry.)

G.CO.11 (9/10) 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.GPE.6. (9/10) Use coordinates to prove simple geometric theorems algebraically, including the use of slope, distance, and midpoint formulas. *For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle.*

G.GPE.7. (9/10) 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*).

UNIT 2: Transformations

ESSENTIAL QUESTION	BIG IDEAS
How do transformations affect 2-dimensional figures?	Students will use tools to discover and model properties of transformations. Students will construct arguments about transformations through mapping and functions. Students will apply properties of transformations to describe the angle relationships within parallel lines.

GUIDING QUESTIONS

Content and Process

- How can angles be translated along a transversal and what are the relationships between angle pairs? **G.CO.7., G.CO.1b.**
- How do reflections and rotations relate to symmetry to carry a figure onto itself? **G.CO.1d.**
- How can tools be used to confirm the properties of isometric transformations? **G.CO.1., G.CO.1a., G.CO.1b., G.CO.1c.**
- How can the output of a preimage be computed? **G.CO.2.**
- How can a sequence of transformations describe the relationship between two figures? **G.CO.3.**
- How can properties of congruent angles help to construct arguments about parallel lines? **G.CO.7.**
- How can the definition of congruence in terms of rigid motions be used to decide if two figures are congruent? **G.CO.5. (+)**

Reflective

- How can I explain and model the difference between the characteristics of a reflection, rotation, and translation?

- How could I convince a friend that two lines are parallel?
- How can I use what I know about vertical angles and linear pairs to verify other angle pair relationships within parallel lines?
- What criteria could I use to show two figures are congruent?

FOCUS STANDARDS

Standards of Mathematical Practice
MP.5 Use appropriate tools strategically.
MP.7 Look for and make use of structure.

Content Standards
G.CO.1. (9/10) Verify experimentally (for example, using patty paper or geometry software) the properties of rotations, reflections, translations, and symmetry.

- **G.CO.1a. (9/10)** Lines are taken to lines, and line segments to line segments of the same length.
- **G.CO.1b. (9/10)** Angles are taken to angles of the same measure.
- **G.CO.1c. (9/10)** Parallel lines are taken to parallel lines.
- **G.CO.1d. (9/10)** Identify any line of reflection and/or rotational symmetry within a figure.

G.CO.2. (9/10) Recognize transformations as functions that take points in the plane as inputs and give other points as outputs and describe the effect of translations, rotations, and reflections on two-dimensional figures. *For example, (x,y) maps to (x+3,y-5) ; reflecting triangle ABC(input) across the line of reflection maps the triangle to exactly one location, A'B'C'(output).*

G.CO.3. (9/10) Given two congruent figures, describe a sequence of rigid motions that exhibits the congruence (isometry) between them using coordinates and the non-coordinate plane.

G.CO.5. (+) Given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G.CO.7. (9/10) Construct arguments about lines and angles using theorems. 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~~. (Building upon standard in 8th grade Geometry.)

UNIT 3: TRIANGLES - PROPERTIES & CONGRUENCE

ESSENTIAL QUESTION	BIG IDEAS
How do transformations reveal the properties within and between triangles?	Students will construct arguments about the relationships within one triangle. Students will construct and defend arguments to show two triangles are congruent.

GUIDING QUESTIONS

Content and Process

- How can transformations be used to show triangles are congruent? **G.CO.4.**
- What properties allow us to determine the base angles of an isosceles triangle are congruent? **G.CO.8**
- How are the angles (interior and exterior) of a triangle related? **G.CO.8**
- Given three points, is the triangle formed isosceles, equilateral, or scalene? Is the triangle right? **G.GPE.6**
- What evidence is needed to construct an argument that two triangles are congruent? **G.CO.9.**
- How are the congruence theorems (SSS, SAS, ASA, AAS, HL) used to prove relationships in figures? **G.CO.9., G.SRT.6.**
- How does slope, distance, and midpoint reveal the relationship between the midsegment and the third side of a triangle? **G.CO.8**
- How can rigid motions be used to establish triangle congruence criteria? **G.CO.6. (+)**

Reflective

- How can I construct an argument that shows two triangles, or parts of two triangles, are congruent?
- How can I use my knowledge of distance and slope to classify a triangle?
- How can I explain to a friend why base angles in an isosceles triangle are congruent?
- How can I use rigid motions to explain triangle congruence?

FOCUS STANDARDS

Standards of Mathematical Practice

MP.3 Construct viable arguments and critique the reasoning of others.
MP.5 Use appropriate tools strategically.

Content Standards

G.CO.4. (9/10) 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.6. (+) Demonstrate triangle congruence using rigid motion (ASA, SAS, and SSS).
G.CO.8 (9/10) Construct arguments about the relationships within one triangle using theorems. 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; angle sum and exterior angle of triangles.
G.CO.9. (9/10) Construct arguments about the relationships between two triangles using theorems. Theorems include: SSS, SAS, ASA, AAS, and HL.
G.SRT.6. (9/10) Use congruence ~~and similarity~~ criteria for triangles to solve problems and to prove relationships in geometric figures.
G.GPE.6. (9/10) Use coordinates to prove simple geometric theorems algebraically, including the use of slope, distance, and midpoint formulas. *For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle.*

UNIT 4: PROPERTIES OF POLYGONS & QUADRILATERALS

ESSENTIAL QUESTION	BIG IDEAS
How does congruence reveal the properties within geometric figures?	Students will apply prior knowledge to discover properties of quadrilaterals. Students will construct arguments about parallelogram properties.

GUIDING QUESTIONS

Content and Process

- Given four points, what is the most specific quadrilateral formed (parallelogram, rectangle, rhombus, square, kite or trapezoid)? **G.GPE.6**
- What do congruent triangles reveal about the properties of parallelograms? **G.CO.10, G.SRT.6**
- Given a parallelogram, what parts can be shown to be congruent? **G.CO.10.**
- How is the distance formula used to compute the perimeter of polygons? **G.GPE.8.**
- How can transformations be used to discover the properties of parallelograms? **G.CO.4**

Reflective

- How can I construct an argument to show two figures, or parts of two figures, are congruent?
- How can I use parallel and perpendicular lines and the distance formula to classify figures?

FOCUS STANDARDS

Standards of Mathematical Practice

MP. 2 Reason abstractly and quantitatively.
MP.7 Look for and make use of structure.

Content Standards

G.CO.4. (9/10) 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.10. (9/10) Construct arguments about parallelograms using theorems. Theorems include: opposite sid are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals. (Building upon prior knowledge in elementary and middle school.)
G.SRT.6. (9/10) Use congruence ~~and similarity~~ criteria for triangles to solve problems and to prove relationships in geometric figures.
G.GPE.6. (9/10) Use coordinates to prove simple geometric theorems algebraically, including the use of slop distance, and midpoint formulas. *For example, prove or disprove that a figure defined by four given points ir the coordinate plane is a rectangle.*
G.GPE.8. (9/10) Use coordinates to compute perimeters of polygons and areas of triangles and rectangles,

including the use of the distance and midpoint formulas.

UNIT 5: SIMILARITY

ESSENTIAL QUESTION	BIG IDEAS
How do dilations affect two-dimensional figures?	Students will identify and apply transformations of similar figures. Students will justify why figures are similar using theorems. Students will apply algebraic methods to solve problems and prove relationships.

GUIDING QUESTIONS

Content and Process

- Given a center and a scale factor, how can geometric constructions verify properties of dilations? **G.SRT.1, G.SRT.1a, G.SRT.1b**
- How can properties of dilations help prove lines parallel? **G.SRT.1a**
- How does the concept of a function relate to similarity transformations of a figure? **G.SRT.2**
- What sequence of transformations reveals the similarity between two similar figures using coordinat and the non-coordinate plane? **G.SRT.3**
- What relationships are necessary for two figures to be similar? **G.SRT.4**
- How can similarity in right triangles be used to prove the Pythagorean Theorem? **G.SRT.5**
- What proportionality relationships can be drawn when a line is parallel to one side of a figure within the figure? **G.SRT.5**
- How can SSS, SAS, and AA triangle similarity theorems be used to solve problems and prove relationships in different geometric figures? **G.SRT.6**

Reflective

- How can I solve problems and prove relationships in geometric figures using what I know about congruence and similarity?
- How can I use parallel lines and the proportionality to classify similar figures?
- How can I convince a friend that two figures, including triangles, are similar?

FOCUS STANDARDS

Standards of Mathematical Practice

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

Content Standards

G.SRT.1. (9/10) Use geometric constructions to verify the properties of dilations given by a center and a sca
factor:

- **G.SRT.1a. (9/10)** A dilation takes a line not passing through the center of the dilation to a parallel lin and leaves a line passing through the center unchanged.
- **G.SRT.1b. (9/10)** The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G.SRT.2. (9/10) Recognize transformations as functions that take points in the plane as inputs and give oth points as outputs and describe the effect of dilations on two-dimensional figures.

G.SRT.3. (9/10) Given two similar figures, describe a sequence of transformations that exhibits the similarity between them using coordinates and the non-coordinate plane.

G.SRT.4. (9/10) Understand the meaning of similarity for two-dimensional figures as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G.SRT.5. (9/10) Construct arguments about triangles using theorems. Theorems include: a line parallel to o side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved us triangle similarity, and AA.

G.SRT.6. (9/10) Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

UNIT 6: Right Triangles & Trigonometry

ESSENTIAL QUESTION	BIG IDEAS
What relationships exist within right triangles?	Students will discover side ratios in right triangles. Students will apply trig ratios to solve problems involving triangles. Students will apply the Pythagorean Theorem. Students will explore basic applications of Law of Sines and Cosines.

GUIDING QUESTIONS

Content and Process

- How does side proportionality in similar right triangles lead to the definitions of trig functions? **G.SI**
- How can the Pythagorean Theorem be used to obtain exact trigonometric ratios for 30°, 45°, and (angles? **G.SRT.7**
- How does sine of an angle relate to the cosine of the angle's complement? **G.SRT.8**
- How can trigonometric ratios be used to solve for missing sides or angles in a right triangle? **G.SR**
- How can the Pythagorean Theorem be used to solve for missing sides in a right triangle? **G.SRT.9.**
- How can the Pythagorean Theorem and trig ratios be extended to solve real world problems? **G.SRT.9.**
- How is the formula $A = \frac{1}{2}ab \sin C$ derived and why is it helpful? **G.SRT.10. (+)**

- How can right triangles be used to prove the Law of Sines? **G.SRT.11. (+)**
- How can Law of Sines and Cosines be used to find unknown measurements in right and non-right triangles? **G.SRT.12. (+)**

Reflective

- How can I connect similarity to trigonometric ratios?
- How do I determine the most effective method to use in order to solve and apply right triangles?
- How can I prove the Law of Sines and use it to find unknown measurements?

FOCUS STANDARDS

Standards of Mathematical Practice

MP.1 Make sense of problems and persevere in solving them.

MP.8 Look for and express regularity in repeated reasoning.

Content Standards

G.SRT.6. (9/10) Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

G.SRT.7. (9/10) Show 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.8. (9/10) Explain and use the relationship between the sine and cosine of complementary angles.

G.SRT.9. (9/10) Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

G.SRT.10. (+) Derive the formula for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

G.SRT.11. (+) Prove the Laws of Sines and Cosines and use them to solve problems.

G.SRT.12. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measureme in right and non-right triangles (*e.g. surveying problems, resultant forces*).

UNIT 7: Area, Surface Area, Volume

ESSENTIAL QUESTION	BIG IDEAS
How are geometric shapes and their properties modeled?	Students will use various strategies to find the areas of quadrilaterals anc regular polygons. Students will calculate density and displacement using area and volume. Students will use geometric figures and technology to model real world objects.

GUIDING QUESTIONS

Content and Process

- How is coordinate geometry used to compute the area of triangles and rectangles? **G.GPE.8**
- How can rectangles and triangles be used to derive the area formulas for quadrilaterals and regu polygons? **G.MG.1**
- How can geometric shapes be used to estimate the circumference, area, surface area, perimeter, volume of a real world object? **G.MG.1**
- How can area and volume be used to calculate density? **G.MG.2.**
- How can volume be used to calculate displacement? **G.MG.2.**
- How can a visual representation of a design problem aid in solving the problem? **G.MG.3**
- How can the formula for the area of a sector be derived? **G.C.6. (+)**
- How can dissections (breaking a figure into familiar shapes) be used to give an informal argumen the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and **G.GMD.1 (+)**
- How can Cavalieri's Principle be used to derive the volume of solid figure? **G.GMD.2 (+)**

Reflective

- How can I determine an object's displacement?
- What are different ways I can break apart a polygon to find its area using shapes I know?

FOCUS STANDARDS

Standards of Mathematical Practice

MP.4 Model with mathematics.

MP.7 Look for and make use of structure.

Content Standards

G.C.6. (+) ~~Derive using similarity the fact that the length of the arc intercepted by an angle is proportiona the radius, and define the radian measure of the angle as the constant of proportionality;~~ derive the form for the area of a sector.

G.GPE.8 (9/10) Use coordinates to compute perimeters of polygons and areas of triangles and rectangle including the use of the distance and midpoint formulas.

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 and informal limit arguments.

G.GMD.2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sc figure.

G.MG.1. (9/10) Use geometric shapes, their measures, and their properties to describe objects *(e.g. mod a tree trunk or a human torso as a cylinder)*

G.MG.2. (9/10) Apply concepts of density and displacement based on area and volume in modeling situations *(e.g. persons per square mile, BTUs per cubic foot)*.

G.MG.3. (9/10) Apply geometric methods to solve design problems *(e.g. designing an object or structure satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios*.

Unit 8: Circles

ESSENTIAL QUESTION	BIG IDEAS
What characteristics and relationships exist within circles?	Students will apply the properties inside and outside of a circle. Students will use coordinate geometry to construct arguments about cir Students will construct arguments for similarity in circles. Students will discover and apply the equation of a circle.

GUIDING QUESTIONS

Content and Process

- How are any two circles similar? **G.C.1**
- What relationships exist between segments inside and outside of a circle? **G.C.2**
- What angle relationships exist when segments are drawn inside and outside of a circle? **G.C.2**
- What are the properties of polygons when inscribed or circumscribed about a circle? **G.C.3**
- Given a graph of a circle, what is the equation of the circle? **G.GPE.1**
- Given a center and radius of a circle, what is the equation of the circle? **G.GPE.1**
- Given the center and radius of a circle, and another point, does the point lie outside, inside, or o circle? **G.GPE.6**
- Given the center and a point on a circle, what is the equation of the line tangent to the circle at t point? **G.GPE.6**
- How can the Pythagorean Theorem be used to find the equation of a circle? **G.GPE.2. (+)**
- How can tools be used to construct inscribed and circumscribed circles for triangles? **G.C.4. (+)**
- How can tools be used to construct inscribed and circumscribed circles for polygons and tanger from a point outside a given circle to the circle? **G.C.5. (+)**
- How are equilateral triangles, squares, and regular hexagons constructed within a circle? **G.CO.**

Reflective

- How do I show two circles are similar?
- How can I explain to a friend how to graph a circle?

- How can I describe and prove the relationships in circles?
- How can I explain to a friend how to write the equation of any given circle?
- What can you learn about a circle from its equation?

FOCUS STANDARDS

Standards of Mathematical Practice

MP.3 Construct viable arguments and critique the reasoning of others.

MP.6 Attend to precision.

Content Standards

G.C.1. (9/10) Construct arguments that all circles are similar.

G.C.2.(9/10) 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 ri angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G.C.3. (9/10) Construct arguments using properties of polygons inscribed and circumscribed about circl

G.C.4. (+) Construct inscribed and circumscribed circles for triangles.

G.C.5. (+) Construct inscribed and circumscribed circles for polygons and tangent lines from a point out given circle to the circle.

G.GPE.1. (9/10) Write the equation of a circle given the center and radius or a graph of the circle; use th center and radius to graph the circle in the coordinate plane.

G.GPE.2. (+) Derive the equation of a circle of given center and radius using the Pythagorean Theorem; the circle in the coordinate plane;

G.GPE.6. (9/10) Use coordinates to prove simple geometric theorems algebraically, including the use o distance, and midpoint formulas. For example, prove or disprove that a figure defined by four given poir the coordinate plane is a rectangle.

G.CO.12. (+) Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

