

# Geometry Honors Unit 1: Foundations of Geometry, Lines & Angles (Gr. 9 - 10)

Content Area: **Mathematics**  
Course(s): **Geometry Honors**  
Time Period: **1st Marking Period**  
Length: **6 Weeks**  
Status: **Published**

## Unit Overview

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As this unit begins, students will review the basic geometric terminology, symbols, line and angle relationships discussed within their summer packets. Following this, students will create basic geometric constructions. They will then begin to discuss logical reasoning as they explore patterns, evaluate the validity of statements and provide counterexamples as appropriate. Building upon this, students will begin to write formal geometric proofs. In addition, students will learn to recognize, write, and evaluate the truth of conditional statements, their converses, inverses, contrapositives, and biconditional statements.

Finally, students will explore the properties of parallel and perpendicular lines and continue their study of deductive reasoning and formal geometric proofs.

## Transfer

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Students will be able to independently use their learning to...

- Relate geometric terminology to real-world settings.
- Create formal constructions to illustrate basic geometric concepts.
- Use available information to reach logical conclusions.
- Construct logical arguments.
- Critique the reasoning of others, providing counterexamples as appropriate.
- Understand and apply the attributes of, and relationships between, lines, transversals, and angles, both analytically and synthetically (in and outside of the coordinate plane).

## Meaning

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## Understandings

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Students will understand that...

- The terms *point*, *line*, and *plane* are undefined terms upon which all other geometric concepts are based.
- The relationships that exist between specific angle pairs are used in solving for unknown measures.
- Mathematical statements are either true or false.

- Statements can be proven false with one counterexample.
- Logical mathematical arguments, known as *proofs*, are used to prove that certain statements are true, and to establish rules in geometry.
- The phrase "if and only if" implies that both a conditional statement and its converse are true.
- Specific angle relationships can be used to distinguish between parallel and non-parallel lines. Conversely, when parallel lines are intersected by a transversal, unique relationships exist between specific angle pairs.
- When working in the coordinate plane, the slopes of two lines can be used to determine whether the lines are parallel, perpendicular, or neither.

## Essential Questions

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Students will keep considering...

- How can geometric figures and their properties be described through careful use of geometric language?
- How can the unique properties of geometric figures be used to determine new information?
- How can available information and logical reasoning be used to develop and prove conjectures?
- When can mathematical properties effectively be written as biconditional statements?
- How can formal geometric constructions be created using a variety of tools?

## Application of Knowledge and Skill

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### Students will know...

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- The meaning of basic geometric terminology and symbols.
- Postulates describing the relationships between points, lines, and planes.
- That bisectors divide angles or segments into two congruent parts.
- The relationships between linear pairs, vertical, supplementary, and complementary angles.
- The distance and midpoint formulas.
- What is meant by writing conjectures.
- That conditional statements and their converses contain both a hypothesis and a conclusion.
- That biconditional statements are used to combine conditional statements and their converses when both statements are true.
- That counterexamples can be used to disprove statements.
- That formal geometric proofs are logical arguments which contain reasons to support each statement that is made.
- That most rules in geometry come in the form of theorems, which are statements that have been proven.
- Which angle pairs are congruent and which are supplementary when parallel lines are intersected by a transversal.

- That specific angle relationships formed when two lines are intersected by a transversal can be used to show that two lines are parallel.
- The properties of perpendicular lines.
- The relationships between the slopes of parallel and perpendicular lines in the coordinate plane.

### **Students will be skilled at...**

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- Using geometric symbols and terminology correctly.
- Using given information and diagrams to make accurate conclusions about points, lines, and planes.
- Using the segment and angle addition postulates to write accurate equations and solve for unknowns.
- Using the relationships between linear pairs, vertical, supplementary, complementary, and bisected angles to write accurate equations and solve for unknowns.
- Making formal geometric constructions to copy a segment, copy an angle, bisect a segment, bisecting an angle, construct perpendicular lines, including the perpendicular bisector of a line segment, and construct a line parallel to a given line through a point not on the line.
- Using the distance formula to calculate the length of a segment or measurement needed to find the area or perimeter of a polygon.
- Calculating the areas and perimeters of simple polygons.
- Using the midpoint formula to find the coordinates of an unknown midpoint or endpoint of a segment.
- Creating and using examples to write valid conjectures.
- Reading and interpreting conditional and biconditional statements.
- Judging the validity of statements and writing counterexamples to disprove them as appropriate.
- Writing simple geometric proofs involving basic angle relationships, parallel and perpendicular lines.
- Solving for unknowns when parallel lines and a transversal are given.
- Using known angle relationships to determine when two lines are parallel or perpendicular.
- Determining the slope of a line given a sketch of the line, the coordinates of two points on the line, or an equation of the line.
- Using their slopes to establish relationships between lines in the coordinate plane.
- Using point-slope and slope-intercept form to write the equation of a line.

### **Academic Vocabulary**

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- acute angle
- adjacent angle
- alternate exterior angles
- alternate interior angles
- angle
- angle bisector
- area
- base

- between
- biconditional statement
- bisect
- collinear
- complementary angles
- conclusion
- conditional statement
- congruent
- congruent angles
- congruent segments
- conjecture
- construction
- contrapositive statement
- converse
- coordinate
- coordinate plane
- coplanar
- corresponding angles
- counterexample
- deductive reasoning
- definition
- degree
- distance
- distance from a point to a line
- endpoint
- exterior of an angle
- height
- hypotenuse
- hypothesis
- image
- inductive reasoning
- interior of an angle
- inverse statement
- leg
- length
- line
- linear pair
- logically equivalent statements
- measure

- midpoint
- obtuse angle
- opposite rays
- parallel lines
- parallel planes
- perimeter
- perpendicular bisector
- perpendicular lines
- plane
- point
- point-slope form
- polygon
- postulate
- preimage
- proof
- quadrilateral
- ray
- right angle
- rise
- run
- same-side exterior angles
- same-side interior angles
- segment
- segment bisector
- skew lines
- slope
- slope-intercept form
- straight angle
- supplementary angles
- theorem
- transversal
- triangle
- two-column proof
- undefined term
- vertex
- vertical angles

### **Learning Goal 1.1 (Summer Packet Review)**

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Students will understand basic geometric terminology, and will create and use sketches and solve problems

involving angle and segment measures.

- Students will understand basic geometric terminology, and will create and use sketches and solve problems involving angle and segment measures.

### **Target 1.1.1 (Level of Difficulty: Retrieval, DOK: 1- Recall)**

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SWBAT identify, name, and sketch points, lines, segments, rays, and planes.

MA.G-CO.A.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.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.4	Model with mathematics.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

### **Target 1.1.2 (Level of Difficulty: Comprehension, DOK: 3 - Strategic Thinking)**

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SWBAT identify linear pairs, adjacent, vertical, complementary, and supplementary angles, and will be able to use given information to solve for unknowns in related problems.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

### **Target 1.1.3 (Level of Difficulty - Comprehension , DOK: 2 - skill)**

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SWBAT apply the midpoint formula to solving for unknown midpoint/endpoint coordinates.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.

### **Learning Goal 1.2**

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Students will understand basic geometric relationships, will create basic geometric constructions, and will calculate areas and perimeters of simple geometric figures.

- Students will perform basic geometric constructions, and will calculate areas and perimeters of basic geometric figures.

### **Target 1.2.1 (Level of Difficulty - Knowledge utilization, DOK 4: Extended Thinking)**

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SWBAT apply the initial postulates & theorems to reach accurate conclusions involving the relationships between points, lines, and planes.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.G-CO.A.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.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.

### **Target 1.2.2 (Level of Difficulty: Analysis, DOK: 3 - Strategic Thinking)**

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SWBAT make formal geometric constructions of:

- congruent segments
- segment bisectors
- congruent angles
- angle bisectors

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.G-CO.A.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.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.6	Attend to precision.
MA.G-CO.D.12	Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).

### **Target 1.2.3 (Level of Difficulty - Knowledge utilization, DOK 4: Extended Thinking)**

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Based on the Pythagorean Theorem, students will derive and use the distance formula to calculate the distance between two points.

MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.7	Look for and make use of structure.
MA.G-GPE.B.7	Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

### **Target 1.2.4 (Level of Difficulty: Comprehension, DOK: 3 - Strategic Thinking)**

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SWBAT solve for areas and perimeters of basic polygons, using the distance formula as needed.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.4	Model with mathematics.
MA.K-12.7	Look for and make use of structure.
MA.G-GPE.B.7	Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

### **Learning Goal 1.3**

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Students will be able to identify patterns, write and evaluate logical statements, and provide counterexamples as appropriate.

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### **Target 1.3.1 (Level of Difficulty: Analysis, DOK: 3 - Strategic Thinking)**

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SWBAT develop examples to illustrate mathematical properties, and will use inductive reasoning to identify patterns and make conjectures.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.K-12.8	Look for and express regularity in repeated reasoning.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.9-10.CCSS.ELA-Literacy.WHST.9-10.1e	Provide a concluding statement or section that follows from or supports the argument presented.

### **Target 1.3.2 (Level of Difficulty - Knowledge utilization, DOK 4: Extended Thinking)**

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SWBAT develop counterexamples to disprove given conjectures.

MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10



texts and topics.

### **Target 1.3.3 (Level of Difficulty: Analysis, DOK: 3 - Strategic Thinking)**

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SWBAT identify, write, and analyze the truth values of conditional statements, as well as their converses, inverses, and contrapositives.

MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.9-10.CCSS.ELA-Literacy.CCRA.R.4	Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

### **Target 1.3.4 (Level of Difficulty: Analysis, DOK: 3 - Strategic Thinking)**

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SWBAT write and analyze biconditional statements.

MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.9-10.CCSS.ELA-Literacy.CCRA.R.4	Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

### **Learning Goal 1.4**

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Students will prove simple theorems involving lines and angles.

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### **Target 1.4.1 (Level of Difficulty - Knowledge utilization, DOK 4: Extended Thinking)**

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SWBAT use properties of equality and congruence to justify mathematical statements and write simple algebraic proofs.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.

MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.

### **Target 1.4.2 (Level of Difficulty - Knowledge utilization, DOK 4: Extended Thinking)**

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SWBAT use a diagram and given information to construct a simple two-column deductive proof relating lines and angles. (Including proof that vertical angles are congruent.)

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.

### **Learning Goal 1.5**

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Students will be able to prove and apply theorems involving parallel lines, transversals, and perpendicular lines.

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### **Target 1.5.1 (Level of Difficulty: Retrieval, DOK: 1 - Recall)**

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SWBAT identify each of the following:

- parallel lines
- perpendicular lines
- skew lines
- transversals
- corresponding angles
- alternate interior angles
- alternate exterior angles
- same-side interior angles
- same-side exterior angles

MA.G-CO.A.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.
MA.K-12.6	Attend to precision.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

### **Target 1.5.2 (Level of Difficulty - Knowledge utilization, DOK 4: Extended Thinking)**

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SWBAT prove theorems about angles formed by parallel lines and a transversals, as well as use these theorems to solve for unknown measures. Theorems should include:

- When a transversal crosses parallel lines, corresponding angles are congruent.
- When a transversal crosses parallel lines, alternate interior angles are congruent.
- When a transversal crosses parallel lines, alternate exterior angles are congruent.
- When a transversal crosses parallel lines, same-side interior angles are supplementary.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.G-CO.C.9	Prove theorems about lines and angles.
MA.K-12.8	Look for and express regularity in repeated reasoning.

### **Target 1.5.3 (Level of Difficulty - Knowledge utilization, DOK 4: Extended Thinking)**

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SWBAT use angles formed when a transversal intersects coplanar lines to prove that two lines are parallel, as well as use these relationships to solve for unknown measures. Theorems should include:

- If two coplanar lines are cut by a transversal so that alternate interior angles are congruent, then the two lines are parallel.
- If two coplanar lines are cut by a transversal so that alternate exterior angles are congruent, then the two lines are parallel.
- If two coplanar lines are cut by a transversal so that same-side interior angles are supplementary, then the two lines are parallel.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.G-CO.C.9	Prove theorems about lines and angles.
MA.K-12.8	Look for and express regularity in repeated reasoning.

### **Target 1.5.4 (Level of Difficulty - Knowledge utilization, DOK 4: Extended Thinking)**

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SWBAT prove and apply theorems about perpendicular lines.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.

MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.G-CO.C.9	Prove theorems about lines and angles.

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### **Target 1.5.5 (Level of Difficulty - Knowledge utilization, DOK 4: Extended Thinking)**

SWBAT formally construct:

- a line parallel to a given line through a point not on the line
- perpendicular lines
- perpendicular bisectors of given line segments.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.5	Use appropriate tools strategically.
MA.G-CO.D.12	Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).

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### **Learning Goal 1.6**

Students will solve problems involving parallel and perpendicular lines in the coordinate plane.

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### **Target 1.6.1 (Level of Difficulty: Comprehension, DOK: 2 - Skill)**

SWBAT use slopes of lines to identify parallel and perpendicular lines in the coordinate plane.

MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.4	Model with mathematics.
MA.K-12.7	Look for and make use of structure.
MA.G-GPE.B.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).

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### **Target 1.6.2 (Level of Difficulty: Comprehension, DOK: 2 - Skill)**

SWBAT write the equation of a line parallel or perpendicular to a given line that passes through a given point.

MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.4	Model with mathematics.

MA.K-12.7	Look for and make use of structure.
MA.G-GPE.B.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).

## **21st Century Life and Careers**

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WORK.9-12.9.1.12.1	The ability to recognize a problem and apply critical thinking and problem-solving skills to solve the problem is a lifelong skill that develops over time.
WORK.9-12.9.1.12.1	Collaboration and teamwork enable individuals or groups to achieve common goals with greater efficiency.
WORK.9-12.9.1.12.2	Critical thinking and problem solving in the 21st century are enhanced by the ability to work in cross-cultural teams in face-to-face and virtual environments.
WORK.9-12.9.1.12.2	Leadership abilities develop over time through participation in groups and/or teams that are engaged in challenging or competitive activities.
WORK.9-12.9.1.12.A.1	Apply critical thinking and problem-solving strategies during structured learning experiences.
WORK.9-12.9.1.12.F.2	Demonstrate a positive work ethic in various settings, including the classroom and during structured learning experiences.
WORK.9-12.9.3.12.C.6	Develop job readiness skills by participating in structured learning experiences and employment seeking opportunities.

## **Summative Assessment**

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- Projects
- Quizzes
- Student Portfolios
- Tests
- Unit 1 Assessment (Common Assessment)

## **Formative Assessment and Performance Opportunities**

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- "I have...Who has..." Review Activities
- Academic Games
- Carousel Activities
- Class Discussions
- Classwork
- Closure Activities
- Concept Sorting Activities
- Do Nows
- Exit Tickets
- Four Corners Activities

- Graphic Organizers
- Homework
- Placemat Activities
- Question-All-Writes
- Quiz-Quiz-Trade Activities
- Station Activities
- Student Interviews
- Student Response Systems
- Student Self-Ratings
- Teacher Observation
- Teacher Questioning
- Think, Pair, Share Discussions
- Thumbs Up/Down
- Whip Around
- Whiteboard Use

## **Differentiation/Enrichment**

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- 504 Accommodations
- Challenge Problems
- IEP Modifications
- Learning Centers/Stations
- Leveled Practice Opportunities
- Scaffolding Questions
- Small Group Instruction
- Student Companion Website Resources
- Technology
- Use of Manipulatives (Paper Strips, Exploragons, etc.)

## **Unit Resources**

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- Textbook: Geometry, Common Core Ed. (Holt McDougal, 2012)
- Textbook Resource Kit & Companion Website: <https://my.hrw.com/>
- Geometer's Sketchpad
- Kuta Software

Additional Websites:

- Dan Meyer's 3-Act Math Tasks:  
<https://docs.google.com/spreadsheets/pub?key=0AjIqyKM9d7ZYdEhtR3BJMmdBWnM2YWxWYVM1UWovTEE&output=htmlG>
- Engage NY: Geometry Lesson Notes & Handouts: <https://www.engageny.org/resource/high-school-geometry>

- Geometry Teacher Mike Patterson's Common Core Teaching Notes: <http://www.geometrycommoncore.com/>
- Khan Academy: <https://www.khanacademy.org/>
- NCTM Illuminations Website: Resources for Teaching Math: <http://illuminations.nctm.org/Default.aspx>
- PARCC Educator Resources: <http://www.parcconline.org/for-educators>
- The Geometer's Sketchpad Resource Center: <http://www.dynamicgeometry.com/>