HONORS GEOMETRY - CS

Grade Level: 9
Credits: 2.5

BOARD OF EDUCATION ADOPTION DATE:

AUGUST 27, 2012

SUPPORTING RESOURCES AVAILABLE IN DISTRICT RESOURCE SHARING
APPENDIX A: ACCOMMODATIONS AND MODIFICATIONS
APPENDIX B: ASSESSMENT EVIDENCE
APPENDIX C: INTERDISCIPLINARY CONNECTIONS
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Honors Geometry - CS

Introduction

Course Philosophy

This course is designed to prepare today's students to use mathematics effectively throughout their lives by connecting the physical and visual world with mathematical concepts. It is intended to lay a solid foundation of spatial sense and logical reasoning processes which can be applied in the students' computer science courses and in future mathematics courses. The traditional laws of logic, reasoning skills, and proofs will aid the students in developing the skills necessary for tracing the logical flow of a computer program.

Course Description

This course addresses the essentials of geometry, plane and solid figures, congruence and similarity, right triangle trigonometry, and reasoning and proof. The infusion of coordinate geometry, transformations, and the use of technology enhances mathematical understanding and problem solving skills.
### Course Map

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<th>Relevant Standards</th>
<th>Enduring Understandings</th>
<th>Essential Questions</th>
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</table>
| G-CO1, G-MG1       | Spatial sense, geometric modeling, and measurement can be used to describe and interpret our physical environment and to solve problems. | - How do you name geometric figures and what symbols are used to represent each?  
- What is the importance of angle classifications?  
- How do you determine if a figure is a polygon?  
- How does geometric modeling impact problem solving for real-life situations? | Diagramming a ray, a line, a segment, angles, and polygons  
Identification of real world examples of each | Class discussion, homework questions, and quiz questions focusing on correctly drawing, labeling, and finding measurements for geometric figures | Unit test, including application questions in which a geometric figure is drawn to represent a situation |
| G-CO9, G-CO10, G-CO11, G-SRT4, G-SRT5 | Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills. | - How is a conjecture formulated?  
- What skills are necessary to refute or verify a conjecture?  
- What role do properties of geometric figures play in proving conjectures? | Do Now questions: Are all squares rectangles? How do you know? | Independent practice in class, homework problems, and quiz questions that involve filling in missing parts to a proof as well as writing a full proof | Proofs on several different unit tests, both fill in the missing parts and writing full proofs |
<table>
<thead>
<tr>
<th>G-CO12</th>
<th>Geometric properties can be discovered and validated through the use of construction tools.</th>
<th>What are the basic tools used in performing constructions?</th>
<th>Drawing arcs and circles with a compass</th>
<th>Independent practice in class of each of the basic constructions, checked by teacher</th>
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<tbody>
<tr>
<td></td>
<td>How can construction tools be used to discover or validate geometric properties?</td>
<td></td>
<td>Homework problems involving application of the basic constructions</td>
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<td></td>
<td>How is constructing on paper similar to constructing using a drawing program on a computer?</td>
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<td>Use of geometry drawing software to perform the same constructions done by hand</td>
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<td>Quiz on basic constructions and their applications</td>
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<td>Project: construct Euler's Line</td>
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<tr>
<th>G-CO2 G-CO4 G-CO5</th>
<th>Transformations are widespread in the real world with applications in areas such as art, science, and sports.</th>
<th>What are the various types of transformations?</th>
<th>Plotting points to form a triangle from given coordinates, performing transformations such as reflections, translations, rotations</th>
<th>Do Now questions involving transformations of the graph of an algebraic equation, aimed at determining whether students recognize a transformation in a different setting</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>How do transformations apply to the real world?</td>
<td></td>
<td>Independent practice, homework problems, and quiz questions geared towards performing specific transformations or identifying what transformation has been applied</td>
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<tr>
<td></td>
<td>What is an example of an object that has had more than one transformation applied to it?</td>
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<td>Questions on a unit test</td>
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<tr>
<td></td>
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<td>Tessellations project</td>
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<td></td>
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<td>Patchwork quilt project using geometry drawing software</td>
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<tr>
<td>G-GPE4</td>
<td>G-GPE5</td>
<td>G-GPE7</td>
<td>G-C3</td>
<td>G-C4</td>
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<tr>
<td>Through coordinate geometry, algebraic methods are used to validate a geometric property or concept. How is coordinate geometry different from traditional geometry? What geometric properties can coordinate geometry validate? How are the placement of axes and coordinates chosen for a coordinate proof?</td>
<td>Plotting points in the coordinate plane given ordered pairs</td>
<td>Geometry drawing software for visual representation of postulates and theorems Worksheet of problems in which students have to set up axes to represent different plane figures Independent practice in class and at home, full coordinate proof on paper involving classifying figures as special quadrilaterals</td>
<td>Coordinate proofs on several different unit tests to classify polygons as special quadrilaterals or to prove parallel/perpendicular lines exist</td>
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<tr>
<th>G-SRT1</th>
<th>G-SRT2</th>
<th>G-SRT3</th>
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<th>G-SRT6</th>
<th>G-SRT7</th>
<th>G-SRT8</th>
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<tbody>
<tr>
<td>Similarity and indirect measurement can be used to solve problems. What is indirect measurement? How can similarity aid in comparing objects and finding missing measures? What is an instance in which indirect measurement is necessary?</td>
<td>Class discussion of how obscure measurements might be taken (e.g., how tall a tree is, how wide a river is, how high an object is flying, etc.)</td>
<td>Practice worksheets, homework problems, and quiz questions that require students to determine whether two figures are similar, and to find missing measures in similar figures</td>
<td>Unit test Through course assessment</td>
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<tr>
<th>G-GMD1</th>
<th>G-GMD3</th>
<th>G-GMD4</th>
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<tbody>
<tr>
<td>Formulas for perimeter, area, and volume are useful for calculating and comparing measures. How are the perimeter and area of geometric figures found? Why is area measured in square units while perimeter is a linear measure? What are the relationships among perimeter, area and volume of similar figures and their parts?</td>
<td>Construction of a figure with a specified perimeter, then a specified area, then a specified volume</td>
<td>Open-ended practice problems Worksheets and homework problems to find perimeter, area, volume, or missing measures of a variety of geometric figures Geometry drawing software to create figures with a specific perimeter or area or to calculate the perimeter or area of any figure drawn</td>
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<tr>
<td>G-GPE1</td>
<td>Circles and their properties can be used to model and interpret real world phenomena.</td>
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<tr>
<td>G-C2</td>
<td>What relationships exist for angles with the vertex inside, outside, or on a circle? What are the properties of segments or lines that intersect a circle? What real world situations can be modeled by circles or arcs?</td>
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<tr>
<td>G-C5</td>
<td>Description of a situation that can be modeled by a circle or an arc of a circle.</td>
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<td>Practice worksheets, homework problems, quiz questions, constructions done by hand, and constructions done using geometry drawing software.</td>
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<thead>
<tr>
<th>N-VM1</th>
<th>Vectors and matrices can be used to represent objects in real world situations as well as transformations of plane figures.</th>
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<tbody>
<tr>
<td>N-VM2</td>
<td>What is meant by the direction and magnitude of a vector? What arithmetic operations can be performed on vectors and matrices? How can matrices be used to represent translations, reflections, rotations, and dilations?</td>
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<tr>
<td>N-VM4</td>
<td>Do Now questions: What is a vector? What is a matrix?</td>
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<tr>
<td>N-VM5</td>
<td>Practice worksheets, homework problems, and quiz questions emphasizing the use of vectors and matrices to represent transformations.</td>
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<tr>
<td>N-VM6</td>
<td>Unit test</td>
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<tr>
<td>N-VM7</td>
<td>Through course assessment</td>
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<td>N-VM8</td>
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<td>N-VM11</td>
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<tr>
<td>N-VM12</td>
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<tr>
<td>Unit Title</td>
<td>Unit Understanding(s) and Goal(s)</td>
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<tr>
<td>Unit 1: Essentials of Geometry</td>
<td>Spatial sense, geometric modeling, and measurement can be used to describe and interpret our physical environment and to solve problems.</td>
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<tr>
<td></td>
<td>At the conclusion of this unit, students will be able to describe, symbolically represent, and measure geometric figures.</td>
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<tr>
<td>Unit 2: Reasoning and Proof</td>
<td>Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills.</td>
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<td>At the conclusion of this unit, students will be able to use deductive and inductive reasoning in a variety of ways, including writing geometric proofs.</td>
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<tr>
<td>Unit 3: Parallel and Perpendicular Lines</td>
<td>Spatial sense, geometric modeling, and measurement can be used to describe and interpret our physical environment and to solve problems.</td>
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<tr>
<td></td>
<td>Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills.</td>
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<td>Geometric properties can be discovered and validated through the use of construction tools.</td>
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<td>At the conclusion of this unit, students will be able to use properties of parallel and perpendicular lines to prove relationships about angle measures and make connections to lines in algebra.</td>
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<tr>
<td>Unit 4: Congruent Triangles</td>
<td>Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills.</td>
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<tr>
<td></td>
<td>Geometric properties can be discovered and validated through the use of construction tools.</td>
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<td>At the conclusion of this unit, students will be able to:</td>
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<tr>
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<td>1. classify triangles.</td>
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<td>2. prove triangles congruent.</td>
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<td></td>
<td>3. use coordinate geometry to investigate triangle relationships</td>
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</tbody>
</table>
| Unit 5: Relationships Within Triangles | Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills.  
Geometric properties can be discovered and validated through the use of construction tools.  
Through coordinate geometry, algebraic methods are used to validate a geometric property or concept.  
At the conclusion of this unit, students will be able to:  
1. use properties of special segments in triangles.  
2. use triangle inequalities within one or two triangles. | 1.5 weeks |
| --- | --- | --- |
| Unit 6: Similarity | Similarity and indirect measurement can be used to solve problems.  
Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills.  
At the conclusion of this unit, students will be able to:  
1. use ratios and proportions to solve geometric problems.  
2. prove two triangles are similar.  
3. use indirect measurement and similarity to solve problems. | 1.5 weeks |
| Unit 7: Right Triangles and Trigonometry | Spatial sense, geometric modeling, and measurement can be used to describe and interpret our physical environment and to solve problems.  
Geometric properties can be discovered and validated through the use of construction tools.  
Similarity and indirect measurement can be used to solve problems.  
At the conclusion of this unit, students will be able to:  
1. use the Pythagorean Theorem and its converse.  
2. use trigonometric ratios and special relationships in right triangles. | 1.5 weeks |
| Unit 8: Quadrilaterals | Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills.  
Geometric properties can be discovered and validated through the use of construction tools.  
Through coordinate geometry, algebraic methods are used to validate a geometric property or concept.  
At the conclusion of this unit, students will be able to:  
1. use angle relationships in polygons.  
2. use properties of parallelograms and classify quadrilaterals by their properties. | 1.5 weeks |
### Unit 9: Properties of Transformations
Transformations are widespread in the real world with applications in areas such as art, science, and sports.
Through coordinate geometry, algebraic methods are used to validate a geometric property or concept.
Vectors and matrices can be used to represent objects in real world situations as well as transformations of plane figures.
At the conclusion of this unit, students will be able to:
1. recognize and perform congruence and similarity transformations.
2. apply matrices and vectors in geometry.

1.5 weeks

### Unit 10: Properties of Circles
Circles and their properties can be used to model and interpret real world phenomena.
Geometric properties can be discovered and validated through the use of construction tools.
Through coordinate geometry, algebraic methods are used to validate a geometric property or concept.
At the conclusion of this unit, students will be able to:
1. apply the terminology and theorems associated with circles and related line segments and angles.
2. write and graph equations of circles.

1.5 weeks

### Unit 11: Measuring Length and Area of Plane Figures
Formulas for perimeter, area, and volume are useful for calculating and comparing measures.
Similarity and indirect measurement can be used to solve problems.
Through coordinate geometry, algebraic methods are used to validate a geometric property or concept.
At the conclusion of this unit, students will be able to:
1. apply the measurement formulas for length, perimeter, and area for polygons and circles.
2. apply length, perimeter, and area ratios in similar polygons.
3. calculate geometric probability.

1.5 weeks

### Unit 12: Surface Area and Volume of Solids
Formulas for perimeter, area, and volume are useful for calculating and comparing measures.
Similarity and indirect measurement can be used to solve problems.
At the conclusion of this unit, students will be able to:
1. demonstrate familiarity with three-dimensional figures, their properties, and the related calculations of their areas and volumes.
2. apply length, perimeter, area, and volume ratios in similar solids.

1.5 weeks
## Honors Geometry - CS Unit 01

### Unit Plan

**Enduring Understandings:**
Spatial sense, geometric modeling, and measurement can be used to describe and interpret our physical environment and to solve problems.

**Essential Questions:**
- How do you name geometric figures and what symbols are used to represent each?
- What is the importance of angle classifications?
- How do you determine if a figure is a polygon?
- How does geometric modeling impact problem solving for real-life situations?

**Unit Goals:**
At the conclusion of this unit, students will be able to:
1. describe, symbolically represent, and measure geometric figures.

**Recommended Duration:** .5 week

### Guiding/Topical Questions

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<th>Guiding/Topical Questions</th>
<th>Content/Themes/Skills</th>
<th>Resources and Materials</th>
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</table>
| What are the specific symbols used to represent basic geometric figures? | Difference between congruence and equality symbols  
Capital letters for points, notation for lines, segments, rays, distance between points, angles, and polygons  
Segment Addition Postulate | Textbook  
Worksheets  
Compass and straight-edge | Write descriptions of everyday objects using geometric terminology.  
Construct a segment. Bisect it. | Draw and label a ray, a line, a segment, angles, and polygons. Identify real world examples of each.  
Diagrams with missing segment lengths |
<table>
<thead>
<tr>
<th>How do you classify angles?</th>
<th>Differences among acute, right, obtuse, and straight angles</th>
<th>Rulers and protractors</th>
<th>Draw and measure angles using a protractor.</th>
<th>Using a protractor, draw a triangle with specific angle measures.</th>
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</thead>
<tbody>
<tr>
<td>What vocabulary is used to describe some relationships two angles can have with each other?</td>
<td>Characteristics of supplementary, complementary, adjacent, and vertical angles Angle Addition Postulate</td>
<td>Compass and straight-edge Geometry drawing software</td>
<td>List the different types of angles and angle pair relationships and make a sketch of each. Construct an angle. Bisect it.</td>
<td>Diagrams with missing angle measures Word problem that describes angles being bisected several times, find a missing measure</td>
</tr>
<tr>
<td>How are polygons classified?</td>
<td>Convex versus concave Names of polygons based on number of sides</td>
<td>Worksheets</td>
<td>Given drawings of several polygons, name them by using the vertices, classify them as convex or concave, and then classify them according to the number of sides. “Always, Sometimes, Never” questions</td>
<td></td>
</tr>
<tr>
<td>How do you find the area and perimeter of a figure?</td>
<td>Area formulas for basic geometric figures</td>
<td>Rulers Graph paper</td>
<td>Sketch on graph paper a triangle, rectangle, and square that have an area of 16 square units and find the perimeter of each.</td>
<td>Multi-step problems such as: “Given different values for the length of a side of a square (x), find each corresponding perimeter (y1) and area (y2). Graph the ordered pairs (x, y1) on one graph and (x, y2) on a separate graph. Describe any patterns seen in the graphs.”</td>
</tr>
<tr>
<td>How do you find the distance and midpoint between two points in the coordinate plane?</td>
<td>Plotting points Using distance and midpoint formulas</td>
<td>Graph paper Geometry drawing software</td>
<td>Given points in different quadrants, plot the points; find the coordinates of the midpoint and the distance between the points. Show that the distance from the midpoint to each endpoint is equal to half the length of the original segment.</td>
<td>Problems such as: “Given three ordered pairs, plot them and determine the type of triangle they form. Do the same for the triangle formed by the midpoints of each side.”</td>
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</table>
MA.9-12.HSG.CO.1  Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

MA.9-12.HSG.MG.1  Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

**Differentiation**

Students may use tangible objects to represent abstract concepts such as letting a piece of paper represent a plane and a pencil represents a line. They can manipulate these objects to see relationships, intersections, etc.

Paper folding can be used to help students visualize bisecting an angle or a segment as well as the concept of midpoint.

Tracing paper, graph paper, rulers, and geometry drawing software can all be used to explore angle measures, distance between points, and midpoint of a segment, perimeter, and area.

Students can create a scrapbook of examples of the specific geometry terms covered in this unit.

**Technology**

Students may utilize online problem solving animations such as creating a floor plan for an apartment, store, or mall.

**College and Workplace Readiness**

Measurement is key to the work of a surveyor. Students may explore problems in surveying by applying concepts of measurement, diagramming, and modeling in this unit.
# Honors Geometry - CS Unit 02

## Unit Plan

### Enduring Understandings:
Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills.

### Essential Questions:
- How is a conjecture formulated?
- What skills are necessary to refute or verify a conjecture?
- What role do properties of geometric figures play in proving conjectures?

### Unit Goals:
At the conclusion of this unit, students will be able to:
1. use deductive and inductive reasoning in a variety of ways, including writing geometric proofs.

### Recommended Duration: 1.5 weeks

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<th>Suggested Assessments</th>
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<tbody>
<tr>
<td>How are patterns recognized and extended?</td>
<td>Inductive reasoning is used to make observations and predict future values based on a pattern</td>
<td>Strategies for finding a numeric pattern</td>
<td>Find the next term of a sequence and write the general rule for the pattern.</td>
<td>Open-ended questions</td>
</tr>
<tr>
<td>What are conditional statements and their related conditionals?</td>
<td>Different forms of a conditional statement such as if p, then q; q if p; etc.</td>
<td>Logic notation for conditionals</td>
<td>Students may work with a partner to share conditional statements and their truth values.</td>
<td>Assessment of determinations of the truth value of partner's conditional statement</td>
</tr>
<tr>
<td>How can algebraic properties be used in logical arguments?</td>
<td>Properties of equality</td>
<td>Algebraic equations for students to solve</td>
<td>Solve an algebraic equation and write a reason for each step.</td>
<td>Questions on quiz and/or test in which students write an algebraic proof</td>
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<tr>
<td>How is a two-column proof written?</td>
<td>Format of a two-column proof</td>
<td>Envelopes containing proofs typed and cut apart into individual pieces</td>
<td>Students may work with a partner to put the statements and reasons of a proof into the correct order by arranging slips of paper.</td>
<td>Proofs on unit test in which students have to fill in the missing statements or reasons</td>
</tr>
<tr>
<td>What is the relationship between vertical angles?</td>
<td>Definition of vertical angles, complementary angles, and supplementary angles</td>
<td>Geometry drawing software</td>
<td>Use a computer drawing program to create a drawing of intersecting lines, measure the four angles and compare their values. Repeat with drawings of two sets of complementary angles.</td>
<td>Determination of missing measurements in angle diagrams</td>
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</tbody>
</table>

**MA.9-12.HSG.CO.9 Prove theorems about lines and angles.**

**Differentiation**

When working with patterns or conditional statements, students may have pre-written ones to work with or may be asked to create their own. Specific guidelines may be given by the teacher to increase the difficulty level when students are creating their own. (For example, write a conditional statement that is false but whose converse is true.)

Proofs can be presented in several formats to accommodate varying learning styles. They can be pre-written and partially completed by the teacher with only a few missing pieces for the students to identify. They can be fully completed and the order mixed up so that students have to put them in the correct order. This can be done on a handout or with cut slips of paper for a student to physically rearrange. For those who are capable of successfully completing a more challenging problem, students may be asked to write a complete proof.

Students can analyze proofs of others for accuracy.
Technology

Students may utilize online problem-solving animations such as using the knowledge and skills of lines segments to prove a variety of statements regarding the distance between shops at the mall.

College and Workplace Readiness

Proofs and patterns exercise skills of logic and deductive reasoning that are crucial to many careers in the computer sciences. Students may begin to explore programming through this unit by flowcharting or diagramming the steps to a proof, or conceiving of how they might instruct a computer to complete a proof.
Honors Geometry - CS Unit 03

**Unit Plan**

**Enduring Understandings:**
Spatial sense, geometric modeling, and measurement can be used to describe and interpret our physical environment and to solve problems. Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills. Geometric properties can be discovered and validated through the use of construction tools.

**Essential Questions:**
- How does geometric modeling impact problem solving for real-life situations?
- What role do properties of geometric figures play in proving conjectures?
- How can construction tools be used to discover or validate geometric properties?
- How is constructing on paper similar to constructing using a drawing program on a computer?

**Unit Goals:**
At the conclusion of this unit, students will be able to:

1. use properties of parallel and perpendicular lines to prove relationships about angle measures and make connections to lines in algebra.

**Recommended Duration:** 1.5 weeks

<table>
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<tr>
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<tbody>
<tr>
<td>What angle pairs are formed by transversals?</td>
<td>Corresponding, alternate interior, alternate exterior, consecutive interior, consecutive exterior angles</td>
<td>Drawings of two lines cut by a transversal, both when the lines are parallel and when they are not parallel</td>
<td>From a diagram, identify pairs of special angles formed by two nonparallel lines and a transversal.</td>
<td>Students identify angle relationships from given diagrams.</td>
</tr>
<tr>
<td>How do parallel lines affect the relationship of the special pairs of angles formed by a transversal?</td>
<td>Establish which pairs are congruent and which pairs are supplementary</td>
<td>Use patty paper or lined notebook paper to discover the relationships of special pairs of angles formed by parallel lines and a transversal. Use geometry drawing software to construct parallel lines and a transversal and measure all angles.</td>
<td>Identify missing angle measures in a diagram involving parallel lines and a transversal.</td>
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<tr>
<td>How can angle relationships be used to prove two lines are parallel?</td>
<td>Review the concept of converse; establish which congruent angles or supplementary angles are sufficient to prove two lines parallel</td>
<td>Use compass and straightedge to construct parallel lines by copying an angle and making corresponding angles congruent. With a partner, complete proofs involving parallel lines.</td>
<td>Construct a parallelogram with compass and straightedge. Write a two-column proof to show that two lines are parallel.</td>
<td></td>
</tr>
<tr>
<td>What are the three forms of a linear equation?</td>
<td>Slope-intercept form, standard form, and point-slope form Review slope formula and how to write the equation of a line given two points Practice changing one form of a linear equation into another form Slopes of parallel/perpendicular lines</td>
<td>Graph equations given in all three forms. Choose the easiest method for graphing each of the three types. Write the equation of a line in a specific form and given specific information.</td>
<td>Write the equation of a line parallel to a given line and passing through a given point. Repeat for a line perpendicular to the given line, passing through the given point. Compare the two equations.</td>
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</tr>
</tbody>
</table>
Differentiation

Students can identify angle relationships from given diagrams, or they can be asked to draw their own diagrams that meet certain criteria (e.g. angle 1 is corresponding with angle 2 but is also an alternate interior angle with angle 3).

Graph paper, rulers, patty paper, construction tools, and a geometry drawing program allow students with varying abilities to recognize angle relationships in different manners.

Graph paper and rulers can be used to aid in forming the equation of a line given specific information.

Students can create real world application questions for each topic in this unit.

Technology

Students may utilize online problem-solving animations such as comparing roller coaster by the steepness of their tracks.

College and Workplace Readiness

Students can act as and analyze the job requirements of physical therapy. Physical therapists must calculate appropriate exercises and other mitigations given such variables as a patient’s age, weight, height, etc.
**Honors Geometry - CS Unit 04**

**Unit Plan**

**Enduring Understandings:**
Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills.
Geometric properties can be discovered and validated through the use of construction tools.

**Essential Questions:**
What role do properties of geometric figures play in proving conjectures?
How can construction tools be used to discover or validate geometric properties?
How is constructing on paper similar to constructing using a drawing program on a computer?

**Unit Goals:**
At the conclusion of this unit, students will be able to:
1. classify triangles.
2. prove triangles congruent.
3. use coordinate geometry to investigate triangle relationships.

**Recommended Duration:** 1.5 weeks

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<tr>
<th>Guiding/Topical Questions</th>
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</thead>
<tbody>
<tr>
<td>In what ways can triangles be classified?</td>
<td>Classifying triangles by angles</td>
<td>Drawings of triangles</td>
<td>Draw examples of different types of triangles based on angles and on side lengths.</td>
<td>Given a diagram, solve for missing measures and then classify the triangle.</td>
</tr>
<tr>
<td></td>
<td>Classifying triangles by side lengths</td>
<td>Rulers</td>
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<td>Protractors</td>
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<td>Graph paper</td>
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<tr>
<td>What are the different methods for proving triangles congruent?</td>
<td>Definition of congruent figures&lt;br&gt;SSS, SAS, ASA, AAS methods&lt;br&gt;HL, LL, LA methods</td>
<td>Patty paper&lt;br&gt;Graph paper&lt;br&gt;Compass and straightedge</td>
<td>Use patty paper to construct congruent triangles and verify that corresponding parts are congruent.&lt;br&gt;Complete a coordinate proof to show two triangles congruent using SSS or HL.&lt;br&gt;Write two-column proofs to prove two triangles congruent using various methods.&lt;br&gt;Construct a triangle congruent to a given triangle and explain what method of proof is being applied.</td>
<td>Complete open-ended questions in which two triangles are proven congruent. Explain which method is being applied.</td>
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</tr>
<tr>
<td>How can congruent triangles be used to prove corresponding sides and angles are congruent?</td>
<td>Definition of congruent figures allows for CPCTC</td>
<td>Envelopes containing pre-written proofs cut into pieces</td>
<td>With a partner, students put the statements and reasons of a proof into the correct order.</td>
<td>Write a two column proof in which two triangles must be proven congruent before stating that corresponding parts are congruent. These congruent parts may be used to prove other information such as parallel lines.</td>
</tr>
<tr>
<td>What special characteristics do isosceles and equilateral triangles have?</td>
<td>Base Angles Theorem and its converse&lt;br&gt;Equilateral and equiangular triangles</td>
<td>Worksheets with practice problems</td>
<td>Students complete independent practice with problems involving isosceles and equilateral triangles.</td>
<td>Find the missing measures in diagrams involving isosceles and equilateral triangles.</td>
</tr>
<tr>
<td>What transformations create an image congruent to the original figure?</td>
<td>Pre-image and image&lt;br&gt;Transformations: translation, reflection, rotation&lt;br&gt;Isometry</td>
<td>Graph paper</td>
<td>Students create a drawing on graph paper. Perform various reflections, translations, and rotations on it. Each time, compare the image to the pre-image. Are they congruent?</td>
<td>Given a figure (or coordinates of vertices), perform several transformations on it. Determine whether or not the original figure is congruent to its image and support this argument.</td>
</tr>
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</table>
Differentiation

To explore congruent triangles students may use graph paper, construction tools, paper folding, or geometry drawing software. Parts of triangles can be measured and compared using any of the above tools.

When proving triangles congruent, the proofs can be done independently or with a partner. They can be fill-in-the-blank or write a full proof. A complete proof can be written and cut into pieces so that a student needs only to arrange it in the correct order.

Transformations can be examined through physical objects such as a cut-out triangle. Students can perform translations, reflections, or rotations with the paper triangle on a desk top or on a set of axes drawn on the board. The physical objects are especially helpful to explore rotations. Graph paper and geometry drawing software also enhance the work with transformations.

Students will analyze a close read provided by the teacher of two applications of congruent triangles.

Technology

Students may utilize online problem-solving animations such as applying the Hinge Theorem to everyday situations, such as comparing distances traveled.

College and Workplace Readiness

Civil engineers work to design key elements of infrastructure, and therefore employ many geometric principles in their work. Students may explore problems in civil engineering through the concepts in this unit.
Honors Geometry - CS Unit 05

**Unit Plan**

**Enduring Understandings:**
Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills.
Geometric properties can be discovered and validated through the use of construction tools.
Through coordinate geometry, algebraic methods are used to validate a geometric property or concept.

**Essential Questions:**
What role do properties of geometric figures play in proving conjectures?
How can construction tools be used to discover or validate geometric properties?
How is coordinate geometry different from traditional geometry?
What geometric properties can coordinate geometry validate?
How are the placement of axes and coordinates chosen for a coordinate proof?

**Unit Goals:**
At the conclusion of this unit, students will be able to:
1. use properties of special segments in triangles.
2. use triangle inequalities within one or two triangles.

**Recommended Duration:** 1.5 weeks

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<tr>
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<tr>
<td>What is a coordinate proof and how is one written?</td>
<td>Setting up axes in a variety of ways for a coordinate proof&lt;br&gt;Slope, midpoint, and distance formulas&lt;br&gt;Parts of a coordinate proof: diagram, algebraic formulas, and a summary</td>
<td>Practice proofs</td>
<td>Write a coordinate proof of the Midsegment Theorem.</td>
<td>Questions on quiz and or test in which a coordinate proof is written</td>
</tr>
<tr>
<td>What special properties exist for the points of concurrency for special segments in a triangle?</td>
<td>Definition of point of concurrency</td>
<td>Patty paper</td>
<td>Students construct triangles and their special segments, finding the point of concurrency for each.</td>
<td>Given a triangle, construct the circumscribed circle.</td>
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<td>Circumcenter, orthocenter, incenter, centroid</td>
<td>Construction tools</td>
<td>Use paper or a geometry drawing program to determine where the point of concurrency lies and to explore its properties.</td>
<td>Given a triangle, construct the inscribed circle.</td>
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<td></td>
<td>Circumscribed circle, inscribed circle</td>
<td>Geometry drawing software</td>
<td></td>
<td>Given a triangle, construct Euler's Line.</td>
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<tr>
<td>If the lengths of two sides of a triangle are known, how can the possible values for the third side be determined?</td>
<td>Sum of the lengths of any two sides of a triangle must be greater than the third side</td>
<td>Straws or craft sticks cut into various lengths</td>
<td>Use straws cut into varying lengths to determine if a triangle can be formed. Summarize what is necessary for a triangle to be formed with given lengths.</td>
<td>Given three side lengths, determine whether or not they can form a triangle.</td>
</tr>
<tr>
<td>What is an indirect proof?</td>
<td>Proof by contradiction</td>
<td>Practice proofs</td>
<td>Guided practice writing indirect proofs.</td>
<td>Question on unit test to write an indirect proof</td>
</tr>
<tr>
<td>What is the relationship between the lengths of the sides of a triangle and the measures of its angles?</td>
<td>Putting side lengths in order if only the angles are known</td>
<td>Diagrams with either side lengths or angle measures provided</td>
<td>Order the side lengths or the angle measures of a given triangle. Determine the longest side length in a figure.</td>
<td>Quiz questions involving diagrams of triangles in which the side lengths or angle measures need to be ordered</td>
</tr>
</tbody>
</table>

*MA.9-12.HSG-CO.10* Prove theorems about triangles.
*MA.9-12.HSG-CO.12* Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).
*MA.9-12.HSG-GPE.4* Use coordinates to prove simple geometric theorems algebraically.
*MA.9-12.HSG-GPE.5* Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).
**Differentiation**

A variety of styles of proof are included in this unit. Students should be exposed to all of them, but may be given a choice as to which type of proof to use for a given problem. This allows for students to work within an area of strength, whether it is a more hands-on style including coordinates, graphs, or constructions, or a more abstract style such as an indirect proof.

Students can pre-read the chapter and create an outline of the important concepts in each section.

**Technology**

Students may utilize online problem-solving animations such as moving points to create a congruent triangle to a given triangle.

**College and Workplace Readiness**

Hydrologists use data to study and predict conditions of ground water, climate, etc. Students may analyze coordinate data to explore problems in hydrology and climate change.
Enduring Understandings:
Similarity and indirect measurement can be used to solve problems.
Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills.

Essential Questions:
What is indirect measurement?
How can similarity aid in comparing objects and finding missing measures?
What is an instance in which indirect measurement is necessary?
What role do properties of geometric figures play in proving conjectures?

Unit Goals:
At the conclusion of this unit, students will be able to:
1. use ratios and proportions to solve geometric problems.
2. prove two triangles are similar.
3. use indirect measurement and similarity to solve problems.

Recommended Duration: 1.5 weeks

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<tr>
<td>If two figures are similar, how can the length of a missing side be calculated?</td>
<td>Ratios and proportions</td>
<td>Worksheets of practice problems</td>
<td>Given word problems, draw a diagram of similar triangles and find missing measures.</td>
<td>Scale drawings of bedrooms or other familiar locations</td>
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<td></td>
<td>Scale factor</td>
<td></td>
<td>Find the actual distance between two cities by using a scale on a map.</td>
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</tr>
<tr>
<td></td>
<td>Use scale drawings to find actual distances</td>
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</tr>
</tbody>
</table>
How can two triangles be proven similar?

- Definition of similar triangles
  - AA similarity, SSS similarity, SAS similarity
  - Self-similar figures (fractals)

Practice proofs

Write a two-column proof to show that two triangles are similar.

Create a Sierpinski Triangle or Sierpinski Carpet.

Create Koch's Snowflake.

Open-ended questions in which two triangles need to be proven similar or similar triangles are used to solve a problem

What proportions can be written if a line is parallel to one side of a triangle?

- Triangle Proportionality Theorem
  - Emphasize choosing between Triangle Proportionality and similar triangles when finding a missing measure in a figure

Geometry drawing software

Use a geometry drawing program to explore proportions in a triangle when a line is drawn parallel to one side.

Draw a triangle on lined notebook paper. Draw a line parallel to one side. Measure the resulting segment lengths and draw conclusions.

Problems such as:

“Given a diagram involving both triangle proportionality and similar triangles, find missing measures and explain which process is used for each missing measure.”

What is meant by dilating a figure in the coordinate plane?

- Plotting points in the coordinate plane
- Using a scale factor to produce coordinates of a dilated figure
- Reduction versus enlargement

Graph paper

Students may work with a partner to construct a triangle, share scale factors, and construct dilation of triangles. The same activity can be done using graph paper and coordinates, or a geometry drawing program, rather than construction tools.

Problems such as:

“Given a drawing in the coordinate plane, describe how to perform a dilation on the figure. Explain how to determine whether the dilation will be a reduction or an enlargement.”

---

MA.9-12.HSG-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

MA.9-12.HSG-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

MA.9-12.HSG-SRT.4 Prove theorems about triangles.

MA.9-12.HSG-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
Differentiation

Similar figures can be studied through physical objects such as figures cut out of paper or shadows formed on the ground at the same time by objects of different heights.

Tools such as graph paper, rulers, colored pencils, compass, and straight-edge allow students to create their own similar figures by hand and measure corresponding parts.

Geometry drawing software makes the drawing and measuring of objects easier and allows for more advanced study of similar objects rather than focusing on the actual construction and measurement.

Technology

Students may utilize online problem-solving animations such as exploring the relationship between the coordinates of a figure and its dilated image.

College and Workplace Readiness

Students can research artists such as M. C. Escher, and identify the transformations that are used. Students may also identify the use of transformation in everyday objects and constructions in order to discuss applications of unit content to everyday construction and design.
Enduring Understandings:
Spatial sense, geometric modeling, and measurement can be used to describe and interpret our physical environment and to solve problems.
Geometric properties can be discovered and validated through the use of construction tools.
Similarity and indirect measurement can be used to solve problems.

Essential Questions:
How does geometric modeling impact problem solving for real-life situations?
How can construction tools be used to discover or validate geometric properties?
How can similarity aid in comparing objects and finding missing measures?

Unit Goals:
At the conclusion of this unit, students will be able to:
1. use the Pythagorean Theorem and its converse.
2. use trigonometric ratios and special relationships in right triangles.

Recommended Duration: 1.5 weeks

<table>
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<tr>
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</thead>
</table>
| How can the lengths of the sides of a triangle be used to classify the triangle as acute, right, or obtuse? | Pythagorean Theorem and its converse
Shortest side is opposite smallest angle | Geometry drawing software | Use geometry drawing software to draw triangles that are acute, right, and obtuse. Measure the side lengths and compare $c^2$ to $a^2 + b^2$. Find the pattern that will indicate which relationships exist for acute, for right, and for obtuse triangles. | Do Now and quiz questions in which three side lengths are given and need to be classified as acute, right, obtuse, or not a triangle |
<table>
<thead>
<tr>
<th>What special relationships are formed when an altitude is dropped to the hypotenuse of a right triangle?</th>
<th>Naming similar triangles (writing a similarity statement)</th>
<th>Calculating geometric mean</th>
<th>Geometric Mean Theorems for altitude and for legs of large right triangle</th>
<th>Draw a diagonal on an index card, cut it into two congruent triangles. On one of those triangles draw the altitude to the hypotenuse and cut into two triangles. This produces three similar triangles. Label the vertices and write a similarity statement and statements of proportionality.</th>
<th>Application problems involving a right triangle with altitude drawn to hypotenuse and missing side lengths</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are the ratios of the side lengths of a 45-45-90 and 30-60-90 triangle?</td>
<td>Pythagorean Theorem</td>
<td>Worksheet of practice problems</td>
<td>Given drawings of 45-45-90 and 30-60-90 triangles, use Pythagorean Theorem to find missing side lengths. Identify the patterns in each special triangle.</td>
<td>Questions on quiz and unit test involving diagrams as well as word problem applications</td>
<td></td>
</tr>
<tr>
<td>How can trigonometric ratios be used to obtain measurements in a triangle?</td>
<td>Trigonometric ratios</td>
<td>Geometry drawing software</td>
<td>Demonstrate meaning of trigonometric ratios by constructing similar right triangles, measuring side lengths, calculating ratios of side lengths, and showing that the ratios are constant for each acute angle. Practice using trigonometric ratios to solve right triangles, especially in word problem format.</td>
<td>Open-ended questions in which side lengths or angle measures of a right triangle need to be found (height of a building, angle of elevation, etc.)</td>
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</tbody>
</table>

MA.9-12.HSG-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).
MA.9-12.HSG-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
MA.9-12.HSG-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.
MA.9-12.HSG-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.
MA.9-12.HSG-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
**Differentiation**

Students can use different representations of similar triangles in order to visualize the Geometric Means Theorems. The triangles can be drawn on paper or cut out of index cards. Plastic models of them can be used for students with a more tactile learning style. Some students may benefit from being able to rotate the triangular shapes or to flip them over.

A computer drawing program is helpful for students who have trouble seeing the abstract concepts presented here, as well as enabling more advanced students to create more complex diagrams to explore.

Students will act as a surveyor and use indirect measures to find the height of a building or tree.

**Technology**

Students may utilize online problem-solving animations such as exploring the angled altitude of a mountain in order to calculate the distance skied down a mountain.

**College and Workplace Readiness**

Careers in space exploration require the use of geometric principles along with physics and other disciplines in the modeling of trajectories, and more. Students may research problems in space exploration related to geometry, and pose potential solutions grounded in geometric modeling.
Honors Geometry - CS Unit 08

Unit Plan

**Enduring Understandings:**
Knowledge of the properties of geometric objects allows for the formulation of conjectures which can be refuted or verified through the application of reasoning skills.

Geometric properties can be discovered and validated through the use of construction tools.

Through coordinate geometry, algebraic methods are used to validate a geometric property or concept.

**Essential Questions:**
What role do properties of geometric figures play in proving conjectures?
How can construction tools be used to discover or validate geometric properties?
What geometric properties can coordinate geometry validate?
How are the placement of axes and coordinates chosen for a coordinate proof?

**Unit Goals:**
At the conclusion of this unit, students will be able to:
1. use angle relationships in polygons.
2. use properties of parallelograms and classify quadrilaterals by their properties.

**Recommended Duration:** 1.5 weeks

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<tbody>
<tr>
<td>How can the measure of an angle of a polygon be determined?</td>
<td>Sum of the interior angles of a convex polygon&lt;br&gt;Sum of the exterior angles of a convex polygon</td>
<td>Drawing of a convex polygon</td>
<td>Complete a discovery activity to determine the sum of the interior angles of a polygon by drawing all diagonals from one vertex and observing the number of triangle formed.</td>
<td>Problems in which students have to find missing angle measures or find the number of sides a polygon</td>
</tr>
<tr>
<td>How does the fact that a polygon is regular impact finding the measurement of its angles?</td>
<td>Regular polygon</td>
<td>Worksheet of practice problems</td>
<td>Given several regular polygons, find the measure of each interior angle. Look for a pattern.</td>
<td>Homework questions involving regular and non-regular polygons</td>
</tr>
<tr>
<td>How can a quadrilateral be proven to be a parallelogram?</td>
<td>Definition of a parallelogram</td>
<td>Properties of a parallelogram</td>
<td>Theorems for two-column proofs</td>
<td>Hand-outs with two-column proofs and coordinate proofs</td>
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<td>Coordinate proof, setting up the axes, using algebraic formulas, and writing a summary</td>
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<td>What information is necessary to prove that a quadrilateral is a rectangle, rhombus, square, trapezoid, or kite?</td>
<td>Definitions and properties of a rhombus, rectangle, square, trapezoid, isosceles trapezoid, and kite</td>
<td>Worksheet of practice problems</td>
<td>Two-column proofs and coordinate proofs</td>
<td>Compass and straightedge</td>
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MA.9-12.HSG-CO.11 Prove theorems about parallelograms.
MA.9-12.HSG-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).
MA.9-12.HSG-GPE.4 Use coordinates to prove simple geometric theorems algebraically.
Differentiation

The degree of difficulty of proofs can be adjusted for students of different abilities. Students may be given the option to choose a style of proof they prefer (two-column, coordinate proof, constructions by hand, constructions on computer).

Graph paper, patty paper, and a computer drawing program may be used to explore properties of special quadrilaterals. For some students, exploring the same characteristics using all three means may provide necessary reinforcement.

Open-ended questions are useful in allowing students flexibility with the method they employ to determine what type of figure a given quadrilateral represents.

Technology

Students may utilize online problem-solving animations such as using properties of quadrilaterals to draw a given quadrilateral.

College and Workplace Readiness

The development of theorems from proofs, and the collaborative work that students do to explore these concepts in this unit, exercise workplace readiness skills that are essential in math and science.
Enduring Understandings:
Transformations are widespread in the real world with applications in areas such as art, science, and sports. Through coordinate geometry, algebraic methods are used to validate a geometric property or concept. Vectors and matrices can be used to represent objects in real world situations as well as transformations of plane figures.

Essential Questions:
What are the various types of transformations?
How do transformations apply to the real world?
What is an example of an object that has had more than one transformation applied to it?
What geometric properties can coordinate geometry validate?
What is meant by the direction and magnitude of a vector?
What arithmetic operations can be performed on vectors and matrices?
How can matrices be used to represent translations, reflections, rotations, and dilations?

Unit Goals:
At the conclusion of this unit, students will be able to:
1. recognize and perform congruence and similarity transformations.
2. apply matrices and vectors in geometry.

Recommended Duration: 1.5 weeks
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<tbody>
<tr>
<td>How are vectors and matrix operations used to translate or reflect a figure?</td>
<td>Vector notation</td>
<td>Graph paper</td>
<td>Plot points that form a triangle. Perform various translations and reflections on the figure. Then represent each transformation with vectors and/or matrices.</td>
<td>Partner activities in class involving the graphing of a figure, performing transformations, and writing matrices for those transformations</td>
</tr>
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<td></td>
<td>Operations with matrices</td>
<td>Rulers</td>
<td></td>
<td>Quiz questions</td>
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<td></td>
<td>Effects on x and y coordinates of a point when reflections are performed over the y-axis, x-axis, the line y = x, the line y = -x, and the origin</td>
<td>Patty paper</td>
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<td>Composite transformations</td>
<td>Computer drawing program</td>
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<tr>
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<td>Isometry (rigid transformation)</td>
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<tr>
<td>How is a figure rotated 90, 180, and 270 degrees about the origin?</td>
<td>Center of rotation</td>
<td>Graph paper</td>
<td>Plot points that form a quadrilateral. Perform various rotations on the figure. Then represent each rotation with a matrix.</td>
<td>Questions on unit test</td>
</tr>
<tr>
<td></td>
<td>Clockwise versus counter-clockwise rotation</td>
<td>Rulers</td>
<td></td>
<td>Patchwork quilt activity involving a computer drawing program</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Computer drawing program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What regular polygons tessellate the plane?</td>
<td>Regular polygons</td>
<td>Paper</td>
<td>Given cut-outs of different figures to trace, determine which ones can be used to tessellate a plane. Students try a variety of figures and keep track of the results.</td>
<td>Tessellations project</td>
</tr>
<tr>
<td></td>
<td>Tessellations</td>
<td>Card stock from which to create template</td>
<td></td>
<td>Questions on quiz and test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Colored pencils or markers</td>
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</tbody>
</table>

- **Vector notation**: Notation used to represent vectors mathematically.
- **Operations with matrices**: Mathematical operations performed on matrices for transformations.
- **Effects on x and y coordinates of a point**: How the coordinates of a point change with different transformations.
- **Composite transformations**: Transformations that combine multiple individual transformations.
- **Isometry (rigid transformation)**: Transformations that preserve distances between points.
- **Center of rotation**: The point around which an object rotates.
- **Clockwise versus counter-clockwise rotation**: Directions for rotation.
- **Regular polygons**: Polygons with all sides and angles equal.
- **Tessellations**: Patterns formed by repeating shapes without gaps or overlaps.
- **Graph paper**: Paper used for graphing and drawing.
- **Rulers**: Measuring tools for linear measurements.
- **Patty paper**: Paper used for folding and creating geometric shapes.
- **Computer drawing program**: Software for computer-aided design and drawing.
- **Paper**: Material used for tracing and drawing.
- **Card stock**: Thicker paper used for creating templates.
- **Colored pencils or markers**: Coloring tools for visual representation.

**Suggested Strategies**

- **Plot points that form a triangle**: Students plot points to form a triangle and then perform various transformations.
- **Perform various translations and reflections on the figure**: Students translate and reflect a figure using vectors and matrices.
- **Plot points that form a quadrilateral**: Students plot points to form a quadrilateral and then perform various rotations.
- **Patchwork quilt activity**: Using a computer drawing program, students construct squares, use reflections and rotations to produce larger squares, and repeat the process to fill the page. Students describe which transformations were used for each step in creating the patchwork quilt design. Different colors should be used within the design.
- **Given cut-outs of different figures to trace**: Students trace various figures to tessellate a plane. They try a variety of figures and keep track of the results.
- **Given drawings of tessellations**: Students identify which transformations were used to produce the design.
<table>
<thead>
<tr>
<th>Question</th>
<th>Materials</th>
<th>How to do it</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are the types of symmetry that a geometric figure may have?</td>
<td></td>
<td>Given drawings of figures, students identify the number of lines of symmetry and/or the number of degrees of rotational symmetry each figure has.</td>
<td>Identification of the types of symmetries used in logos</td>
</tr>
<tr>
<td>Rotational symmetry - list the degrees up to 360</td>
<td>Paper, Graph paper, Rulers</td>
<td>Given a description of the type of symmetry, students draw a figure to match the description, or describe an example of a real-world object that would have that type of symmetry.</td>
<td>Questions on quiz or test</td>
</tr>
<tr>
<td>What are the two types of dilations and how are they distinguished from one another?</td>
<td>Reduction, Enlargement, Scale factor (ratio of new measure to previous measure)</td>
<td>Plot points to form a polygon. Perform a reduction or enlargement by applying arithmetic to the coordinates.</td>
<td>Student drawings of dilations</td>
</tr>
<tr>
<td></td>
<td>Graph paper, Rulers, Compass, Computer drawing program</td>
<td>Repeat the reduction or enlargement by using compass and straightedge to construct the polygon and its image.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perform dilations using a computer drawing program.</td>
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</tbody>
</table>

| MA.9-12.HSN-VM.1 | Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., $\mathbf{v}$, $|\mathbf{v}|$, $||\mathbf{v}||$, $v$). |
| MA.9-12.HSN-VM.2 | Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. |
| MA.9-12.HSN-VM.4 | Add and subtract vectors. |
| MA.9-12.HSN-VM.5 | Multiply a vector by a scalar. |
| MA.9-12.HSN-VM.6 | Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network. |
| MA.9-12.HSN-VM.7 | Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled. |
| MA.9-12.HSN-VM.8 | Add, subtract, and multiply matrices of appropriate dimensions. |
| MA.9-12.HSN-VM.11 | Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors. |
| MA.9-12.HSN-VM.12 | Work with $2 \times 2$ matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area. |
| MA.9-12.HSG-CO.2 | Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch). |
| MA.9-12.HSG-CO.4 | Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments. |
| MA.9-12.HSG-CO.5 | Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another. |
| MA.9-12.HSG-GPE.4 | Use coordinates to prove simple geometric theorems algebraically. |
### Differentiation

This unit allows for a variety of materials to be used. Polygon tiles or figures cut out of card stock can be used for a student to explore translations, reflections, rotations, and the concept of tessellating a plane. Transformations can be done with manipulatives, drawn on paper, plotted on graph paper, or drawn on a computer. The use of different colors for pre-image and image will enable students to identify transformations easier.

### Technology

Students may utilize online problem-solving animations such as creating tessellations.

### College and Workplace Readiness

Students can write a summary of a close reading of informational text relating to the use of vectors in engineering.
Honors Geometry - CS Unit 10

Unit Plan

Enduring Understandings:
Circles and their properties can be used to model and interpret real world phenomena.
Geometric properties can be discovered and validated through the use of construction tools.
Through coordinate geometry, algebraic methods are used to validate a geometric property or concept.

Essential Questions:
What relationships exist for angles with the vertex inside, outside, or on a circle?
What are the properties of segments or lines that intersect a circle?
What real world situations can be modeled by circles or arcs?
How can construction tools be used to discover or validate geometric properties?
What geometric properties can coordinate geometry validate?

Unit Goals:
At the conclusion of this unit, students will be able to:
1. apply the terminology and theorems associated with circles and related line segments and angles.
2. write and graph equations of circles.

Recommended Duration: 1.5 weeks
<table>
<thead>
<tr>
<th>Guiding/Topical Questions</th>
<th>Content/Themes/Skills</th>
<th>Resources and Materials</th>
<th>Suggested Strategies</th>
<th>Suggested Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>How are the measures of the various angles that are formed by the intersection of lines and a circle calculated?</td>
<td>Measure of an arc of a circle, Measure of a central angle, Measure of an inscribed angle, Measure of an angle formed by two chords intersecting inside a circle, Measure of an angle formed by secants and/or tangents intersecting outside the circle, Tangent line is perpendicular to radius at point of tangency, Inscribed versus circumscribed polygons</td>
<td>Worksheet of drawings involving circles and lines or segments, Computer drawing program, Compass and ruler</td>
<td>Students explore inscribed angles using construction materials to determine their relationship with central angles. Students complete patty paper and construction assignment to determine if a quadrilateral inscribed in a circle has supplementary angles.</td>
<td>Diagrams with missing measures to be included on quiz and/or unit test</td>
</tr>
<tr>
<td>What are some properties of chords, secants, and tangents to a circle?</td>
<td>Lengths of tangent segments, secant segments, and segments of intersecting chords</td>
<td>Worksheet of drawings involving circles and lines or segments, Computer drawing program, Compass and ruler</td>
<td>Investigate on computer drawing program to explore segment lengths. Use construction tools to discover measure of secant segments and tangent segments.</td>
<td>Diagrams with missing measures to be included on quiz and/or unit test</td>
</tr>
<tr>
<td>What information is necessary for writing the equation of a circle in standard form?</td>
<td>Identify coordinates of center of circle, Calculate length of radius</td>
<td>Graph paper, Rulers, Compass</td>
<td>Given the coordinates of the center of a circle and the length of its radius, write the equation and graph the circle. Given an equation of a circle, complete the square and identify the coordinates of the center and the length of the radius. Given a circle, construct a circle with a radius twice as long, half as long, etc.</td>
<td>Open-ended questions for standard equation of a circle using cell towers, for example</td>
</tr>
</tbody>
</table>
Differentiation

Circular objects can be brought in by students to use as manipulatives, or some can be created by drawing them with a compass and cutting them out of paper or card stock. Colored pencils can be used to differentiate segment lengths or angles within a complex drawing. The use of a compass to draw circles by hand or a computer drawing program will enable students to spend less time drawing and more time exploring lengths and measures of various segments and angles.

Technology

Students may utilize online problem-solving animations such as investigating inscribed angles in a circle.

College and Workplace Readiness

Students can collaborate to calculate the volume of water in a cylindrical water tower. They will list all measurements needed to calculate those unobtainable from the ground.
Honors Geometry - CS Unit 11

Unit Plan

Enduring Understandings:
Formulas for perimeter, area, and volume are useful for calculating and comparing measures.
Similarity and indirect measurement can be used to solve problems.
Through coordinate geometry, algebraic methods are used to validate a geometric property or concept.

Essential Questions:
How are the perimeter and area of geometric figures found?
Why is area measured in square units while perimeter is a linear measure?
What are the relationships among perimeter, area and volume of similar figures and their parts?
What is indirect measurement?
How can similarity aid in comparing objects and finding missing measures?
What is an instance in which indirect measurement is necessary?
What geometric properties can coordinate geometry validate?

Unit Goals:
At the conclusion of this unit, students will be able to:
1. apply the measurement formulas for length, perimeter, and area for polygons and circles.
2. apply length, perimeter, and area ratios in similar polygons.
3. calculate geometric probability.

Recommended Duration: 1.5 weeks
<table>
<thead>
<tr>
<th>Guiding/Topical Questions</th>
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<th>Suggested Strategies</th>
<th>Suggested Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What are the important formulas for finding areas of specific polygons?</strong></td>
<td>Area formulas for triangle, parallelogram, rectangle, square, rhombus, kite, trapezoid</td>
<td>Paper</td>
<td>Complete a discovery activity for area of a parallelogram by dividing a parallelogram into two triangles.</td>
<td>Open-ended questions involving calculating the perimeter/area of various polygons or drawing possible polygons with a given perimeter/area</td>
</tr>
<tr>
<td></td>
<td>Calculating area of irregular figures</td>
<td>Graph paper</td>
<td>Use the area of a parallelogram to find the area of a trapezoid.</td>
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<tr>
<td></td>
<td>Area of regular polygons</td>
<td>Rulers</td>
<td>Cut out a kite and rearrange it pieces to form a rectangle; compare their area formulas.</td>
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<td></td>
<td>Review of right triangle trigonometry and its applications to finding areas</td>
<td>Scissors</td>
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<tr>
<td></td>
<td>Geometric probability</td>
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</tr>
<tr>
<td><strong>What is the relationship between the areas of two similar polygons?</strong></td>
<td>Similar figures</td>
<td>Worksheet of drawings of similar figures</td>
<td>Given drawings of similar figures, measure the corresponding side lengths and angle measures; look for a pattern.</td>
<td>Questions in which students will need to write proportions to solve for missing measures in similar polygons</td>
</tr>
<tr>
<td></td>
<td>Scale factor</td>
<td>Rulers</td>
<td></td>
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<tr>
<td></td>
<td>Ratio of areas is equal to the square of the ratio of corresponding sides</td>
<td>Computer drawing program</td>
<td>Given the dimensions of a figure, construct a similar figure with a given area.</td>
<td></td>
</tr>
<tr>
<td><strong>How can the area of a sector or a segment of a circle be found?</strong></td>
<td>Calculating arc length in a circle</td>
<td>Worksheet of drawings of circles</td>
<td>Given a circle with a specific radius and measure of central angle, calculate the area of a sector as well as a segment of that circle.</td>
<td>Open-ended questions involving area of a whole pizza, one slice, or just the crust. Explore how the areas change as the diameter of the pizza changes. Explore various costs versus size of the pizza pie from neighboring restaurants.</td>
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<td>Area of a sector - a fraction of the area of the circle</td>
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<td></td>
<td>Area of a segment of a circle - involves area of a sector and area of a triangle</td>
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</table>
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.

Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone.

**Differentiation**

Area of figures can be explored through real-world objects which the students can actually measure and calculate. Drawing figures on graph paper allows for the boxes to be used to describe the area of figures. More abstract problems involve drawings on plain paper or word problems with no diagram provided. The level of difficulty of area problems is easily adjusted by changing the way the information is presented to the student (through words only or with a diagram). Open-ended questions allow for a student to approach an area question in several ways. Sharing the various approaches used by several students allows for the discovery of new methods.

**Technology**

Students can create a spreadsheet to find perimeters and areas of a regular n-gon or find the measures of the interior angles of regular n-gons.

**College and Workplace Readiness**

Students can act as a landscape design company and will use measurement to outline a landscape and make scale drawings. They can also perform a wide variety of calculations related to the project design as well as day-to-day business operations. Strong visualization skills are helpful and familiarity with computer aided design (CAD) software is important. A good landscape designer must have the critical thinking skills needed to be a good problem solver in order to plan a design that meets a budget, fits well with the surrounding area, and uses plants and materials that are appropriate for the given environment.
Honors Geometry - CS Unit 12

Unit Plan

Enduring Understandings:
Formulas for perimeter, area, and volume are useful for calculating and comparing measures.
Similarity and indirect measurement can be used to solve problems.

Essential Questions:
How are the perimeter and area of geometric figures found?
What are the relationships among perimeter, area and volume of similar figures and their parts?
How can similarity aid in comparing objects and finding missing measures?
What is an instance in which indirect measurement is necessary?

Unit Goals:
At the conclusion of this unit, students will be able to:
1. demonstrate familiarity with three-dimensional figures, their properties, and the related calculations of their surface areas and volumes.
2. apply length, perimeter, area, and volume ratios in similar solids.

Recommended Duration: 1.5 weeks
<table>
<thead>
<tr>
<th>Guiding/Topical Questions</th>
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<th>Resources and Materials</th>
<th>Suggested Strategies</th>
<th>Suggested Assessments</th>
</tr>
</thead>
<tbody>
<tr>
<td>How is the surface area calculated for a right prism, right pyramid, right cylinder, or right cone?</td>
<td>Polyhedra</td>
<td>Three-dimensional models of solids</td>
<td>Given a net of a three-dimensional figure, predict what it will look like and then fold it and tape it to create the solid. Compare prediction with final product.</td>
<td>Questions that require finding the missing measures in a three-dimensional figure (diagonals, heights, etc) and then calculating the surface area of the figure</td>
</tr>
<tr>
<td></td>
<td>Nets</td>
<td>Worksheet of drawings of prisms, pyramids, cylinders, and cones</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Oblique versus right Prisms</td>
<td>Graph paper</td>
<td>Complete surface area investigation involving graph paper.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pyramids</td>
<td>Nets to fold into polyhedra</td>
<td>Students may work with a partner to find the missing measures and calculate lateral area and surface area, given drawings of geometric solids.</td>
<td></td>
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<tr>
<td></td>
<td>Regular pyramid</td>
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<tr>
<td></td>
<td>Cylinders</td>
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<tr>
<td></td>
<td>Cones</td>
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<tr>
<td></td>
<td>Lateral area and surface area</td>
<td></td>
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</tr>
<tr>
<td>What are the various formulas to determine the volume of different solids?</td>
<td>Volume of prism/cylinder</td>
<td>Worksheet of problems involving three-dimensional figures</td>
<td>Given a prism and pyramid with the same base and height, compare their volumes.</td>
<td>Open-ended questions involving calculating the surface area and/or volume of three-dimensional figures</td>
</tr>
<tr>
<td></td>
<td>Volume of pyramid/cone</td>
<td></td>
<td>Given a cylinder and cone with the same base and height, compare their volumes.</td>
<td>Determining which type of container would hold more, or cost less to make, etc.</td>
</tr>
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<td></td>
<td>Volume of sphere</td>
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<tr>
<td></td>
<td>Cavalieri's Principle</td>
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<tr>
<td>If two solids are similar, what is the ratio of their surface areas and what is the ratio of their volumes?</td>
<td>Similar solids</td>
<td>Worksheet of problems involving three-dimensional figures</td>
<td>Given the drawings of similar solids, create a table to compare their linear measures (length of edge, height, slant height, perimeter, etc), their areas (lateral and surface), and their volumes.</td>
<td>Determination of cost per square and/or cubic inch, given the linear measures of two similar solids and the area or volume of just one</td>
</tr>
<tr>
<td></td>
<td>Scale factor</td>
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</tr>
<tr>
<td></td>
<td>Corresponding linear measures</td>
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</tbody>
</table>
MA.9-12.HSG-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

MA.9-12.HSG-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.

MA.9-12.HSG-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

MA.9-12.HSG-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

**Differentiation**

Volume of figures can be explored through real-world objects which the students can actually measure and calculate. The level of difficulty of volume problems is easily adjusted by changing the way the information is presented to the student (through words only, word description with a diagram provided, or the use of a three-dimensional model). Open-ended questions allow for a student to approach a volume question in several ways. Sharing the various approaches used by several students allows for the discovery of new methods.

**Technology**

Students may use online problem-solving animations such as using Cavalieri's Principle to compare the volume of two solids.

**College and Workplace Readiness**

Students can be grouped to discuss the properties of various solids and determine the surface area and volume of a teacher-specified solid such as toddler playground components. Students may then discuss costs and other factors of manufacturing/sale.