

## Geometry Learning Targets

The following items are the learning targets for Geometry. They are the concepts a student in Geometry should know and be able to apply consistently by the end of each unit. Since mathematics is cumulative in nature, many learning targets are expected to be used not only in the unit where they are introduced, but throughout the course. The learning targets are broken up by quarter and by unit of study. Most units follow the sequencing of our textbook, *Geometry for Enjoyment and Challenge*, with publisher McDougall, Littell and Company.

### **1<sup>st</sup> Quarter:**

#### **Chapter 1: Introduction to Geometry (sections 1.1-1.4 of the text and teacher-created materials)**

1. Define, diagram, and symbolize the basic constructs of geometry such as points, lines, rays, segments, angles, and triangles.
2. Define, symbolize, and visualize intersection and union, and given a diagram solve problems using intersection and union.
3. Identify, mark, and symbolize congruent segments and angles.
4. Measure and classify angles as acute, right, obtuse, or straight.
5. Apply the definitions of right, straight, or congruent angles to write and solve equations.
6. Identify what can be assumed and what can't be assumed from diagrams.
7. Convert angle measures written as decimals in degrees into degrees, minutes, and seconds (and vice versa).
8. Add and subtract angle measures in degrees, minutes, and seconds.
9. Find the angle in degrees between the hour and minute hands of a clock at a specified time.
10. Apply the definitions of betweenness and angle addition, which we call part + part = whole, to write and solve equations.
11. Apply the definition of midpoint or angle bisector to write and solve equations.
12. Write paragraph proofs to justify conclusions using all the definitions and theorems in this unit.

#### **Chapter 1 continued: Logic (teacher-created materials separate from the textbook)**

13. Classify a real-life situation as either deductive or inductive reasoning.
14. Write and symbolize the negation of a statement, including the negation of a statement involving "all" (universal statements) or "some" (existential statements).
15. Write and symbolize conjunctions, disjunctions, and conditional statements.
16. Complete truth tables involving negations, conjunctions, disjunctions, and conditional statements.
17. Given a conditional statement, write the converse, inverse, and contrapositive.
18. Use logic symbols to rewrite an argument and determine if the argument is valid.
19. Write the missing statement in a chain of reasoning.
20. Logically deduce the correct conclusion based on given statements.

## **Chapter 2: Basic Concepts and Proofs (omit section 2.6 from the text)**

1. Write paragraph and two-column proofs using all the new definitions and theorems in this unit.
2. Define, symbolize, and apply the definition of perpendicular to write and solve equations or proofs.
3. Apply the concept of right angles are congruent to write and solve equations or proofs.
4. Define and identify complementary angles (complements), supplementary angles (supplements), perpendicular pairs, and linear pairs.
5. Solve for the supplement and complement of a given angle in degrees and in degrees, minutes, and seconds.
6. Apply the definitions of supplements and complements to write and solve equations and systems of equations.
7. Summarize and apply the congruent complements and supplements theorems to write and solve equations or proofs.
8. Summarize and apply the addition and subtraction theorems to write and solve equations or proofs.
9. Describe the difference between the substitution and transitive properties and be able to use each appropriately when writing proofs.
10. Define and identify vertical angles and opposite rays.
11. Apply the concept of vertical angles are congruent to write and solve equations or proofs.
12. Given a geometric term, be able to correctly deduce what is known.
13. Given a list of given information, be able to write a logical conclusion and state the reason.
14. Use Geometer's Sketchpad to construct geometric diagrams, to measure segments, angles and circles, and to construct midpoints and angle bisectors.

## **Chapter 3: Congruent Triangles**

1. Write paragraph and two-column proofs using all the new definitions and theorems in this unit.
2. Define, identify, name, and symbolize congruent figures including triangles.
3. Mark and symbolize corresponding congruent parts of congruent triangles.
4. Apply the reflexive property in proofs.
5. Slide, reflect, and rotate triangles on the coordinate plane.
6. Identify and apply the postulates for proving congruent triangles (SSS, SAS, ASA, HL), and identify when there is not enough information to prove congruent triangles.
7. Use CPCTC (corresponding parts of congruent triangles are congruent) in proofs and use this to prove other facts about the figure.
8. Identify parts of a circle, apply the circumference and area formulas, and use the concept of all radii of a circle are congruent to write proofs.
9. Identify congruent overlapping triangles, and write proofs involving overlapping triangles.
10. Define, identify, and sketch altitudes and medians of triangles, and apply the definitions of altitude and median to write and solve equations or proofs.
11. Draw auxiliary lines in diagrams and document this step in a proof.
12. Classify triangles according to their sides, and write and solve equations or proofs involving special triangles (scalene, isosceles, equilateral).
13. Apply angle-side theorems to write and solve equations or proofs.
14. Determine which angle (or which side) in a triangle is the largest (or smallest).
15. Present proofs from homework assignments on the board during this unit.

## **2<sup>nd</sup> Quarter:**

### **Chapter 4, 5A: Introduction to Parallel Lines (sections 4.1, 4.4, 4.5, 5.2, and 5.3)**

1. Determine the midpoint of a segment on the number line, on the coordinate plane, and using the midpoint formula.
2. Define, identify, and sketch the perpendicular bisector of triangles.
3. Apply the definition of perpendicular bisector to write and solve equations or proofs.
4. Write proofs that use multiple congruent triangles.
5. Identify and name important angle pairs formed by transversals.
6. Identify and determine slopes of lines that are parallel or perpendicular.
7. Given congruent (or supplementary) angles, determine the theorem that justifies which lines are parallel.
8. Given parallel lines, determine the theorem that justifies which angles are congruent (or supplementary).
9. Use the theorems involving parallel lines to write and solve equations, systems, or proofs.

### **Chapter 5B: Quadrilaterals (sections 5.4 – 5.7)**

1. Define, name, and identify polygons.
2. Identify convex and concave polygons.
3. Identify the properties of each special quadrilateral. The properties of all the quadrilaterals are nicely summarized in Section 5.5.
4. Apply the properties of the quadrilaterals to write and solve equations or proofs.
5. Prove that a quadrilateral is a parallelogram.
6. Identify the most descriptive name of a quadrilateral given a list of properties.
7. Find the most descriptive name of a quadrilateral plotted on the coordinate plane by analyzing the slope of opposite and consecutive sides or by analyzing the diagonals.

### **Chapter 6: Lines and Planes in Space**

1. Identify and label planes, and describe the four ways to define a plane.
2. Define, identify, and label the foot of a line in a plane.
3. Use the theorems involving a line(s) perpendicular to a plane through the foot to write proofs.
4. Describe and symbolize the intersection of two planes.
5. Apply the theorems involving planes or lines and planes that are perpendicular or parallel to each other to write proofs.
6. Apply the transitive property of parallel planes to write proofs.

### **3-D Proof Project (a rubric will be provided to the students in advance):**

This is the final assessment for Chapter 6 and includes the following learning targets:

7. Use postulates and theorems to prove a relationship about a 3-D figure (with special emphasis on proving triangles congruent).
8. Build an accurate, sturdy 3-D model of a diagram.
9. Draw a two-dimensional diagram to represent a 3-D model.

### **Chapters 7, 15: Polygons, Triangle Inequalities, Hinge Theorems (omit section 15.1)**

1. Apply the sum of the measures of the three angles of a triangle to find missing angles.
2. Apply the exterior angle theorem to find the missing angles in a figure.
3. Apply the midline theorem to find the missing angles or missing side lengths in a figure.
4. Define, identify, and name quadrilateral, pentagon, hexagon, heptagon, octagon, nonagon, decagon,  $n$ -gon.
5. Apply the appropriate formula to find the sum of the interior angles, the sum of the exterior angles, the number of diagonals, or the number of sides of a polygon.
6. Be able to explain why the formula for the sum of the interior angles or the number of diagonals of a polygon works.
7. Apply the appropriate formula to find the missing interior angle measure, exterior angle measure, the number of sides, or the measure of the central angle of a regular polygon.
8. Write a two-column proof using the no choice and AAS theorems.
9. Write an indirect proof for a conclusion that cannot be proved directly (e.g., lines not parallel, angles not congruent, segments not congruent etc.).
10. Apply the triangle inequality postulate to determine if a triangle with the given sides exists.
11. Apply the triangle inequality postulate to determine a possible range of values for the missing side of a triangle.
12. Apply the exterior angle inequality theorem to determine a possible range of values for a missing remote interior angle or exterior angle of a triangle.
13. List the sides and angles of a triangle in increasing or decreasing order using the theorem that the largest (or smallest) angle in a triangle is across from the largest (or smallest) side.
14. Apply the Hinge Theorem and its converse to determine which angle (or side) is larger.
15. Write paragraph and two-column proofs using the theorems and postulates stated above.

### **Chapter 8: Similar Polygons**

1. Compute a ratio about a real-life situation and reduce it to lowest terms.
2. Determine the arithmetic and geometric means for two given numbers.
3. Apply the Means-Extremes Product Theorem to algebraically solve for a ratio like  $x:y$ .
4. Set up a proportion to solve a real-life problem.
5. Define and symbolize similar figures.
6. Use the properties of similar figures to find missing angle measures and to set up proportions to find the missing side lengths.
7. Identify which two triangles are similar in a given diagram and
8. Prove similar triangles using AA, AAA, or SSS~.
9. Apply the concept of corresponding sides of similar triangles are proportional to set up a proportion that can be solved or to set up a proportion in a proof.
10. Apply the three section 8.5 theorems to set up a proportion to algebraically find the missing side of a figure.
11. Write two-column proofs using similar triangle theorems and concepts.

### **3<sup>rd</sup> Quarter**

#### **Chapter 9: Pythagorean Theorem and Right Triangle Trigonometry**

1. Perform operations involving square roots and write the answer in simplest radical form.
2. Solve a quadratic equation (and simplify the answer completely) by finding square roots, factoring, and using the quadratic formula.
3. Find the arc measure, arc length, and area of a sector of a circle.
4. Recognize similar triangles that are formed when an altitude is drawn to the hypotenuse of a right triangle.
5. Use altitude-on-hypotenuse theorems or similar triangle proportions to find missing lengths when an altitude is drawn to the hypotenuse of a right triangle.
6. Use the Pythagorean Theorem to find the length of the unknown leg or hypotenuse in a right triangle.
7. Determine if a triangle is right, obtuse, or acute using the Pythagorean Theorem Test.
8. Apply the Pythagorean Theorem to more advanced problem-solving situations (e.g., find the altitude of an isosceles trapezoid, the perimeter of a rhombus, the missing side of a spiral, etc.)
9. Find the distance between two points on the coordinate plane using the distance formula.
10. Verify that a triangle is right by comparing slopes and by using the distance formula and the Pythagorean Theorem.
11. Recognize that Pythagorean triples (and multiples of those triples) can be useful to know in order to speed up mathematical processes.
12. Use the Pythagorean Theorem to derive the special right triangle relationships and the formula for the diagonal of a box.
13. Use the special right triangle relationships to find the missing sides of 30-60-90 and 45-45-90 triangles effectively.
14. Apply the special right triangle relationships to more advanced problem-solving situations (e.g., finding the perimeter of an equilateral triangle, trapezoid, etc.)
15. Find the length of the diagonal of a box.
16. Apply the formula for the diagonal of a box to more advanced problem-solving situations.
17. Use the Pythagorean Theorem to find the length of the altitude, slant height, lateral edge, and base edge of a pyramid.
18. Find the sine, cosine, and/or tangent of an angle.
19. Use sine, cosine, and tangent to find the missing side of a right triangle (including real-life applications involving angle of elevation and depression).
20. Use inverse sine, cosine, and tangent to find the missing angle of a right triangle (including real-life applications involving angle of elevation and depression).

## **Chapter 10: Circles**

1. Find the circumference, area, radius, diameter, arc measure, arc length, and area of a sector of a circle.
2. Work backward given the arc length or area of a sector to find the measure of an arc of a circle.
3. Complete a diagram and apply the Sections 10.1 – 10.4 Theorems to find the length of a chord, radius, tangent, or distance from the chord to the center of a circle. (Overall, the students need to be able to apply any of the circle theorems in order to find a missing piece of information; this often involves creating a right triangle.)
4. Use the walk-around method to find missing information (e.g., the radii of three externally tangent circles or the perimeter of a quadrilateral circumscribed about a circle).
5. Find the length of the common external tangent of two circles when given the circles' radii.
6. Complete a two-column proof using circle theorems and be able to describe the theorems in one's own words.
7. Use the inscribed angle theorem to find the measures of angles and arcs associated with a quadrilateral inscribed in a circle.
8. Apply the Section 10.5, 10.6, and 10.7 Theorems to find the measure of angles and arcs.
9. Find the radius of a circle circumscribed about or inscribed in a regular polygon.
10. Find the perimeter of a figure and solve application problems comprised of circles, semicircles, rectangles, squares, triangles, etc.
11. Determine the lengths of segments formed by chords, secant segments and tangent segments using the power theorems.

## **4<sup>th</sup> Quarter:**

### **Chapter 11: Area**

1. Describe the difference between perimeter/circumference (linear units) and area (square units)
2. How to find the area (and perimeter) of a square, rectangle, parallelogram, triangle (all types), trapezoid, kite, rhombus, regular polygon, and circle. (Note: The students should also be able to find the area of a shape that is a combination of any of the shapes above.)
3. Given the area of a shape (trapezoid, triangle, etc.), work “backwards” to find the missing dimension.
4. Use counting (subtraction) to find the horizontal distance (base) and vertical distance (height) in order to find the area of a triangle plotted on the coordinate plane.
5. Use subtraction to find the area of a shaded region (e.g., the segment of a circle).
6. Calculate the ratio of the areas of non-similar figures.
7. Calculate the ratio of the areas of two similar figures.
8. Calculate the ratio of the areas of triangles with the same height (and be able to explain why it is the same as the ratio of the bases).
9. Use Hero's Formula to find the area of any triangle.
10. Use Brahmagupta's Formula to find the area of a cyclic quadrilateral.

### **Tessellation Project (a rubric will be provided to the students in advance):**

1. Create an original hand drawn tessellation beginning with an equilateral triangle, quadrilateral, or regular hexagon and using a variety of methods: translate, translate and reflect, rotate about a midpoint, or rotate about a vertex.

## Chapter 12: Surface Area and Volume

1. Describe the difference between surface area and volume and use the appropriate units for length (linear) versus surface area (square) versus volume (cubic).
2. Find the lateral area, total surface area, and volume of prisms, cylinders (including fractions of cylinders), pyramids, cones, frustums, and spheres (including hemispheres). The students should also be able to find the surface area and volume of figures that are made up of a combination of any of the above figures.
3. Work “backwards”: given the surface area or volume, find the requested dimension (Note: this may require solving a quadratic equation by factoring or solving a cubic equation by taking a cube root.)
4. The similarities and differences between pyramids and prisms and between cones and cylinders
5. Draw an appropriate diagram of a prism, cylinder, pyramid, cone, frustum, or sphere in order to label the given information and find the surface area and volume.
6. Explain the derivation of the formula for the total surface area of a cylinder.
7. Describe a sphere using its geometric definition.
8. Given the net of a rectangular prism, draw the box that results.
9. Solve a multi-step real-life problem (e.g., find the height of the water that is left over after a cylinder of water fills a rectangular pan).

## Chapter 13: Coordinate Geometry

1. Graph a line using a table of values, the slope and  $y$ -intercept, the  $x$  and  $y$ -intercepts, and a point and the slope.
2. Write the equation of a line in slope-intercept, point-slope, and standard form in a wide variety of situations (e.g., given its graph, given two points on the line, etc.).
3. Write the equation of a horizontal or vertical line.
4. Understand and apply the concept of slopes of parallel and perpendicular lines.
5. Write the equation of the line that is an altitude, median, or perpendicular bisector of a triangle.
6. Solve a system of linear equations graphically or algebraically (using the substitution method or the elimination method).
7. Graph the solution set to a system of linear inequalities and given the graph, write the system of inequalities.
8. Plot a 3-D point using rectangular solids to help visualize the position.
9. Find the distance between two points in 3-D space using the 3-D distance formula.
10. Visualize a 3-D solid from a graph and find its surface area and volume.
11. Given the equation of a circle in standard form, graph it; label the center, radius, and 4 other key points.
12. Use completing the square to put the equation of a circle in standard form.
13. Given a circle’s center and radius, write the equation of the circle in standard form, verify if a point lies on that circle, and write the equation of the line tangent to the circle at a specified point.
14. Find the area of a figure that has been plotted on a coordinate grid.
15. Draw and label an appropriate diagram to write a coordinate proof involving distance, slope (parallel or perpendicular), and/or midpoint.