West Virginia Mathematics

Geometry

Adopted 2024

Geometry

Basics of Geometry

1. Experiment with transformations in the plane. G.BG.1
    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. M.GHS.1
2. Identify and utilize inductive and deductive reasoning. G.BG.2
    2. Construct and justify the validity of a logical argument. M.GHS.2
        a. Identify the converse, inverse, and contrapositive of a conditional statement. M.GHS.2.A
        b. Translate a short, verbal argument into symbolic form. M.GHS.2.B
        c. Use Venn diagrams to represent set relationships. M.GHS.2.C
        d. Use inductive and deductive reasoning. M.GHS.2.D
3. Prove geometric theorems. G.BG.3
    3. Use appropriate methods of proof to prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent. M.GHS.3
4. Use coordinates to prove simple geometric theorems algebraically. G.BG.4
    4. Find the point on a directed line segment between two given points that partitions the segment in a given ratio. M.GHS.4
5. Make geometric constructions. G.BG.5
    5. Make formal geometric constructions with a variety of tools and methods, such as a compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.: M.GHS.5
        a. copying a segment; M.GHS.5.A
        b. copying an angle; M.GHS.5.B
        c. bisecting a segment; M.GHS.5.C
        d. bisecting an angle; M.GHS.5.D
        e. constructing perpendicular lines, including the perpendicular bisector of a line segment; and M.GHS.5.E
        f. constructing a line parallel to a given line through a point not on the line. M.GHS.5.F

Transformations and Congruence

1. Experiment with transformations in the plane. G.TC.1
    6. Build on prior knowledge from rigid motions to: M.GHS.6
        a. represent transformations using geometric concepts in the plane. M.GHS.6.A
        b. describe transformations as functions that take points in the plane as inputs and give other points as outputs. M.GHS.6.B
        c. compare transformations that preserve distance and angle to those that do not. M.GHS.6.C
    7. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself. M.GHS.7
    8. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments. M.GHS.8
    9. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, for example, graph paper, tracing paper, or geometry software. Describe a sequence of transformations that will carry a given figure onto another. M.GHS.9
2. Understand congruence in terms of rigid motions. G.TC.2
    10. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent. M.GHS.10
    11. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent. M.GHS.11
    12. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions. M.GHS.12
    13. Use congruence criteria for triangles to solve problems and to prove relationships in geometric figures. M.GHS.13
3. Prove geometric theorems. G.TC.3
    14. Use appropriate methods of proof to prove theorems about triangles and lines. Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints. M.GHS.14
    15. Use appropriate methods of proof to prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals. M.GHS.15
4. Use coordinates to prove simple geometric theorems algebraically. G.TC.4

16. Use coordinates to prove simple geometric theorems about right triangles, quadrilaterals, and circles algebraically (e.g., derive the equation of a circle of given center and radius using the Pythagorean Theorem). M.GHS.16

Similarity and Trigonometry

1. Understand similarity in terms of similarity transformations. G.ST.1

    17. Verify experimentally the properties of dilations given by a center and a scale factor. M.GHS.17

        a. A dilation takes a line not passing through the center of the dilation to a parallel line and leaves a line passing through the center unchanged. M.GHS.17.A

        b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor. M.GHS.17.B

    18. 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. M.GHS.18

    19. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar. M.GHS.19

2. Prove theorems involving similarity. G.ST.2

    20. Use appropriate methods of proof to prove theorems about triangles involving similarity. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity. M.GHS.20

    21. Use similarity criteria for triangles to solve problems and to prove relationships in geometric figures. Use the Pythagorean Theorem and similarity criteria to derive and apply special right triangles to solve problems. M.GHS.21

3. Define trigonometric ratios and solve problems involving right triangles. G.ST.3

    22. 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. M.GHS.22

    23. Explain and use the relationship between the sine and cosine of complementary angles. M.GHS.23

    24. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. M.GHS.24

4. Apply trigonometry to general triangles. G.ST.4

    25. Derive the formula A = ½ ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side. M.GHS.25

    26. Prove the Laws of Sines and Cosines extending the definitions of sine and cosine to obtuse angles. M.GHS.26

    27. Understand and apply the Law of Sines and the Law of Cosines to solve problems and to find unknown measurements in right and non-right triangles. M.GHS.27

Circles

1. Understand and apply theorems about circles. G.C.1

    28. Prove that all circles are similar. M.GHS.28

    29. Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle. M.GHS.29

2. Find arc lengths and areas of sectors of circles. G.C.2

    30. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector. M.GHS.30

3. Make geometric constructions. G.C.3

    31. Construct the inscribed and circumscribed circles of a triangle and prove properties of angles for a quadrilateral inscribed in a circle. M.GHS.31

    32. Construct a tangent line from a point outside a given circle to the circle. M.GHS.32

    33. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle. M.GHS.33

Extending to Three Dimensions and Modeling

1. Explain volume formulas and use them to solve problems. G.E3D.1

    34. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments. M.GHS.34

    35. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems, including how area and volume scale under similarity transformations. M.GHS.35

2. Visualize the relation between two-dimensional and three-dimensional objects and apply geometric concepts in modeling situations. G.E3D.2

    36. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. M.GHS.36

    37. Use two- and three-dimensional shapes and circles, their measures, and their properties to describe objects. M.GHS.37

        a. Apply concepts of density based on area and volume in modeling situations. M.GHS.37.A

        b. Apply geometric methods to solve design problems to satisfy given constraints. M.GHS.37.B

Statistics and Probability

1. Understand independence and conditional probability and use them to interpret data. G.SP.1

    38. Describe events as subsets of a sample space using characteristics of the outcomes or as unions, intersections, or complements of other events. M.GHS.38

    39. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities. Use this characterization to determine if they are independent. M.GHS.39

    40. Recognize the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B. M.GHS.40

    41. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. M.GHS.41

    42. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. M.GHS.42

2. Use the rules of probability to compute probabilities of compound events in a uniform probability model. G.SP.2

    43. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A and interpret the answer in terms of the model. M.GHS.43

    44. Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B) and interpret the answer in terms of the model. M.GHS.44

    45. Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B) and interpret the answer in terms of the model. M.GHS.45

    46. Use permutations and combinations to compute probabilities of compound events and solve problems. M.GHS.46

3. Use probability to evaluate outcomes of decisions. G.SP.3

    47. Use probabilities to make fair decisions. M.GHS.47

    48. Analyze decisions and strategies using probability concepts. M.GHS.48