

Course III Curriculum

TEXTBOOKS: Excerpts from The Art of Problem Solving: Introduction to Geometry by Richard Rusczyk,; The Art of Problem Solving: Introduction to Counting and Probability by David Patrick; Excerpts from The Art of Problem Solving: Intermediate Algebra by Richard Rusczyk and Matthew Crawford; Transformational Geometry by Richard Brown; eMathInstruction, Common Core Geometry, <https://emathinstruction.com/common-core-geometry/>

PROBABILITY

- COUNTING: counting lists of numbers; counting with addition and subtraction; counting multiple events; permutations
- BASIC COUNTING TECHNIQUES: complementary counting; constructive counting; counting with restrictions
- CORRECTING FOR OVERCOUNTING: permutations with repeated elements; counting pairs of items; counting with symmetries
- COMMITTEES AND COMBINATIONS: committee forming; how to compute combinations; first combinatorial identity
- MORE WITH COMBINATIONS: paths on a grid; distinguishability
- COUNTING PROBLEMS: harder counting problems
- INTRODUCTION TO PROBABILITY: basic probability; equally likely outcomes; counting techniques in probability problems
- BASIC PROBABILITY TECHNIQUES: probability and addition; complementary probabilities; probability and multiplication; probability with dependent events
- GEOMETRIC PROBABILITY: probability using lengths; probability using areas
- EXPECTED VALUE: definition; problems
- PASCAL'S TRIANGLE: constructing pascal's triangle; an interesting combinatorial identity; another combinatorial identity
- THE HOCKEY STICK IDENTITY: problem; solution; identity
- THE BINOMIAL THEOREM: algebra; the binomial theorem; applications; using in identities

TRANSFORMATIONAL and ANALYTIC GEOMETRY

- THE GEOMETRY OF TRANSFORMATIONS: maps and mappings; one-to-one mappings; transformations; mappings in algebra; functions; isometries; problems solved by reflections; properties of isometries; rotations; translations and glide reflections; symmetry; the fundamental theorems of isometries
- THE ALGEBRA OF TRANSFORMATIONS: the composite (product) of mappings; the algebra of translations; the algebra of half-turns; the algebra of rotations; groups; transformation groups; symmetry groups
- ANALYTIC GEOMETRY: Equations of Lines and Circles; Proofs with Analytic Geometry; Distance between a Point and a Line

CONIC SECTIONS

- CIRCLES: construction given center and radius; equations of circles in coordinate plane
- ELLIPSES: construction given foci-pins and string; concentric circles construction; paper folding construction; equations of ellipses in coordinate plane; eccentricity; area; applications of ellipses
- PARABOLAS: construction given focus and directrix; sliding ruler method; concentric circles construction; paper folding construction; equations of parabolas in coordinate plane; application of parabolas
- HYPERBOLAS: construction of hyperbolas based on foci; concentric circles construction; eccentricity; equation of hyperbolas in coordinate place; asymptotes; application of hyperbolas
- OPTIMIZATION: pre-calculus solutions (using ellipses) to burning tent and swimming pool problems

GEOMETRY with EMATH INSTRUCTION

- **ESSENTIAL GEOMETRIC TOOLS AND CONCEPTS:** points, distance, and segments; lines, rays, and angles; types of angles; complements and supplements; circles and arcs; constructing a triangle; geometry terminology; properties of lines
- **TRANSFORMATIONS, RIGID MOTIONS AND CONGRUENCE:** transformations; rotations; reflections; isosceles triangles; translations; congruence and rigid motion; basic rigid motion proofs; congruence reasoning with triangles; symmetries
- **EUCLIDEAN TRIANGLE PROOF:** givens; axioms of equality; triangle congruence theorems; proofs with partitioning; parallel properties
- **CONSTRUCTIONS:** angles and parallel lines; perpendicular lines; circumscribed circles; bisecting an angle; inscribed circle of a triangle; inscribing regular polygons
- **TOOLS OF COORDINATE GEOMETRY:** slope and parallelism; slope and perpendicularity; equations of lines; point-slope form of a line; horizontal and vertical lines; pythagorean theorem; distance formula; midpoint formula; rotations in the coordinate plane; reflections in the coordinate plane; translations in the coordinate plane
- **QUADRILATERALS:** trapezoids and parallelograms; properties of parallelograms; midpoints of a triangle; rectangles; rhombus; squares
- **DILATIONS AND SIMILARITY:** dilations; dilations in the coordinate plane; dilations and angles; similarity and its criteria; reasoning with similarity; side splitter theorem; partitioning a line segment; medians of a triangle; right triangles and similarity; proving the Pythagorean theorem
- **RIGHT TRIANGLE TRIGONOMETRY:** similar right triangles; trigonometric ratios; trigonometry and the calculator; solving for missing sides of a right triangle; trigonometric applications
- **CIRCLE GEOMETRY:** terminology; inscribed angles; intersecting chords; tangents to a circle; tangents, secants, and angles; tangent and secant proofs; equations of circles; standard form; constructing tangents; equations of tangent lines
- **MEASUREMENT AND MODELING:** perimeter; circumference; area of polygons; area of circle; sectors of circles; radian measure; solids and cross sections; volume of prisms and cylinders; volume of pyramids and cones; spheres; volume of truncated cone