

**Syllabus Scope & Purpose:** The Group G syllabus covers advanced junior secondary mathematics, preparing learners for national and international Olympiads. Contestants are expected to set up equations confidently and spot deep algebraic and geometric structures.

## 1 Numbers and Operations

- ▶ Finding missing terms and unknowns in complex operations using precise precedence rules.
- ▶ Computing cleverly by recognising algebraic identities (difference of squares, factoring patterns).

## 2 Number Theory and Digits

- ▶ Prime and composite number theory; unique prime factorization.
- ▶ Divisibility rules for 3, 5, 15, and properties of digit-swap sums ( $N - N_{\text{rev}}$ ).
- ▶ Remainder arithmetic: finding a common divisor from two remainders; Chinese Remainder type problems.
- ▶ Determining the units digit and cyclic periodicity of high integer powers ( $a^n$ ).

## 3 Fractions, Ratio, Proportion and Percentages

- ▶ Complex percentage discounts, markups, and profit-margin calculations.
- ▶ Ratio dynamics: change in ratios when uniform quantities are added to both antecedents.
- ▶ Chained compound ratios ( $a:b:c$ ).
- ▶ Quantities whose products with given coefficients are identical.
- ▶ Direct and inverse proportion systems ( $y \propto 1/x$ ).
- ▶ Percentage change in area when length and width undergo independent percentage changes.

## 4 Algebra and Word Problems

- ▶ Forming and solving linear equations and simultaneous systems of two linear equations from word problems.
- ▶ Substitution, expansion, and simplification of multi-variable algebraic expressions.
- ▶ Age problems involving mixed units (ages in months compared against years).
- ▶ Classical heads-and-legs systems and multi-segment journey route problems.
- ▶ Averages (mean, median, mode): mathematical effects of adding, removing, or shifting values.

## 5 Rates: Motion and Work

- ▶ Two objects in convergent motion (moving toward each other) with staggered start times.
- ▶ Upstream and downstream river current navigation problems.
- ▶ Multi-pipe inflow and outflow pool filling/drainage rate equations.

## 6 Measurement and Scale

- ▶ Time calculations crossing hour boundaries (e.g. 155 minutes prior to 14:00).
- ▶ Cartographic map scales (e.g. 1 : 500,000) and representative fraction distance conversions to kilometres.
- ▶ Circumference, circular arcs, and distance travelled by clock hands (using  $\pi = 22/7$ ).
- ▶ Volume and surface area of cuboids: fluid displacement techniques and 3D dimensional scaling.

## 7 Geometry and Coordinate Geometry

- ▶ Angle calculations in composite figures combining squares, triangles, and equilateral triangles.
- ▶ Interior and exterior angle sums of regular and irregular  $n$ -gons.
- ▶ Area of a rhombus from perpendicular diagonals; area of parallelograms and trapezoids.
- ▶ Pythagorean theorem in special trapeziums with mutually perpendicular diagonals.
- ▶ Coordinate plane transformations: translations, reflections across axes, and negative coordinates.
- ▶ Solid geometry: counting vertices, faces, and edges after corner-cutting truncations; cuboids assembled from unit blocks.

## 8 Counting, Probability and Sets

- ▶ Enumerating numbers within a given numerical range satisfying digit constraints (e.g. containing 7, exactly one 5).
- ▶ Ordered selections (e.g. choosing 1st and 2nd favourite from 7 items) and sequence restrictions (no button pressed twice consecutively).
- ▶ Spherical geometry counting: counting spherical regions partitioned by parallels and meridians.
- ▶ Theoretical probability derived from ratios, counting techniques, and sample spaces.
- ▶ Two overlapping sets given as percentage distributions.

## 9 Logic, Patterns and Extremal Reasoning

- ▶ Determining the generative recursive formula for sequences of rational fractions and projecting future terms.
- ▶ Extremal reasoning: determining maximum or minimum shares under strict inequality constraints.

### PROBLEM-SOLVING STRATEGIES & MATHEMATICAL HABITS

Grade 8 contestants are expected to set up equations confidently and to spot structure before calculating. Key Olympiad problem-solving strategies include: Algebraic Substitution, Extremal Principle, Invariant Testing, Modulo Arithmetic, Venn Sets, Pigeonhole Principle, Geometric Projection, and Proof by Contradiction.