MARKHOR JUNIOR

MATHEMATICS CURRICULUM

Aspirant Level

Class 9 · Class 10 · O-Level · A-Level

An Original International-Standard Mathematics Framework

Official Curriculum Document
Markhor Junior Contest
2026

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1. Introduction & Curriculum Philosophy

The Markhor Junior Mathematics Curriculum — Aspirant Level represents the highest academic tier of the Markhor Junior Contest structure, covering four progressive tracks: Class 9, Class 10, O-Level and A-Level. It builds directly on the Pioneer Level (Class 7 & 8) and completes the full Markhor Junior progression: Nursery/KG → Beginner (Class 1–2) → Learner (Class 3–4) → Elementary (Class 5–6) → Pioneer (Class 7–8) → Aspirant (Class 9–10 / O-Level / A-Level).

The Aspirant Level follows the progression: Understand → Apply → Analyze → Generalize → Reason → Justify → Model → Solve. Crucially, the four tracks are not treated as a single ladder of increasing difficulty on identical content: Class 9 and Class 10 develop secondary mathematics foundations and analytical thinking; O-Level deepens this into internationally-benchmarked secondary mathematics with more rigorous proof and advanced algebra, geometry, statistics and probability; and A-Level introduces genuinely advanced pure and applied mathematics — including calculus and matrices — that is never present in the other three tracks. A-Level is not merely "O-Level with harder questions"; it has its own advanced mathematical structure, detailed from Section 20 onward.

This document is the official foundation for all future Markhor Junior Aspirant Level materials, including MCQ question banks, practice tests, mock tests, past papers and contest papers for all four tracks.

2. Curriculum Architecture

The curriculum follows a consistent architecture for every topic:

- Track → Class/Qualification → Mathematical Domain → Topic → Subtopics → Learning Outcomes → Skills → Prerequisites → Difficulty → Assessment Mapping

Eighteen mathematical domains are used consistently across all four tracks — extending the Pioneer Level structure with Functions, Exponentials & Logarithms, Trigonometry, Vectors, Matrices and Calculus as substantial domains, with Matrices and Calculus appearing exclusively within the A-Level track:

- Number Systems & Number Theory (NT)
- Algebra (AL)
- Exponentials & Logarithms (EL)
- Functions (FN)
- Equations & Inequalities (EQ)
- Sequences & Series (SQ)
- Euclidean Geometry (GE)
- Coordinate Geometry (CG)
- Mensuration (MN)
- Trigonometry (TR)
- Statistics (ST)
- Probability (PR)
- Combinatorics & Counting (CO)
- Vectors (VE)
- Matrices (MA)
- Calculus (CL)
- Mathematical Logic, Proof & Reasoning (LR)
- Problem Solving & Mathematical Modelling (PS)

3. Three-Tier Difficulty System

Every topic is structured across three difficulty levels, applied consistently within each track's own academic standard. Challenge is created through hidden relationships, multiple concepts, strategic thinking, generalization, elegant solutions and proof-like reasoning — never simply through content outside the track's official syllabus.

- Level 1 — Foundation: direct concept understanding and standard application.
- Level 2 — Advanced: multi-step application, unfamiliar situations and analytical reasoning.
- Level 3 — Challenge: high-level, non-routine mathematical reasoning, which may involve hidden relationships, multiple concepts, strategic thinking, generalization, elegant solutions, proof-like reasoning, optimization, multiple conditions or counterexamples.

4. Track-Specific Differentiation

Each track has a distinct academic focus and is not simply a harder version of the previous one:

- Class 9 — Secondary Mathematics Foundation + Algebraic Thinking + Geometry + Mathematical Reasoning.
- Class 10 — Advanced Secondary Mathematics + Analytical Thinking + Multi-Step Problem Solving.
- O-Level — International Secondary Mathematics + Advanced Algebra + Geometry + Statistics + Probability + Mathematical Reasoning.
- A-Level — Advanced Mathematics + Pure Mathematics + Applied Mathematics + Advanced Problem Solving, including calculus, matrices, advanced vectors, and rigorous proof (direct, contradiction, introductory induction).

5. Spiral Curriculum & Connection to Pioneer Level

The Aspirant Level connects naturally with the Pioneer Level: Class 9 extends Pioneer Level algebra, geometry and reasoning into full secondary mathematics (quadratics, the Pythagorean theorem, right-triangle trigonometry, grouped statistics). Each subsequent track then deepens every domain further — Class 10 introduces the sine/cosine rules, standard deviation and introductory vectors; O-Level introduces the full set of circle theorems, formal proof, sets, and advanced trigonometric identities; and A-Level introduces genuinely new pure and applied mathematics (differentiation, integration, matrices, binomial distribution, 3D vectors) — without unnecessary repetition at any stage.

6. Mathematical Connections

Topics are not taught in isolation. Question writers should draw on these natural connections when designing reasoning and challenge-level items:

- Number Theory ↔ Algebra (algebraic representation of divisibility and parity claims)
- Algebra ↔ Functions (equations as the algebraic definition of function behaviour)
- Functions ↔ Coordinate Geometry (graphs as the visual representation of functions)
- Algebra ↔ Sequences (the nth term and recursive rules as generalised algebraic relationships)
- Ratio ↔ Trigonometry (trigonometric ratios as a specialised application of ratio reasoning)
- Geometry ↔ Trigonometry (right-triangle and non-right-triangle methods solving the same class of problems)
- Geometry ↔ Vectors (vector methods offering an alternative route to classical geometric proof)
- Probability ↔ Combinatorics (counting outcomes as the foundation of probability calculation)
- Statistics ↔ Probability (distributions bridging descriptive statistics and probabilistic reasoning)
- Calculus ↔ Functions (the derivative and integral as operations defined on functions)
- Calculus ↔ Geometry (optimization and area problems solved using differentiation and integration)
- Calculus ↔ Mathematical Modelling (rates of change and accumulation modelling real-life processes)
- Matrices ↔ Coordinate Transformations (matrices as an alternative representation of transformations)
- Vectors ↔ Coordinate Geometry (vector and coordinate methods proving the same geometric results)

7. Mathematical Proof & Justification

Proof and justification develop progressively across the four tracks: Class 9–10 emphasize accessible, proof-like reasoning (always/sometimes/never, simple structured algebraic and geometric proofs); O-Level increases formal reasoning (formal congruence/similarity proofs, rigorous multi-theorem geometric proofs, introductory proof by

contradiction); and A-Level introduces genuinely rigorous mathematical argument, including formal proof by contradiction and an introduction to proof by mathematical induction. This strand is woven throughout Logical Reasoning, Geometry, Algebra and Problem Solving rather than taught in isolation.

8. Mathematical Communication

Across all four tracks, students develop the ability to explain a method, justify a conclusion, interpret mathematical notation, compare solution methods, identify errors, critique an argument, construct a mathematical argument, interpret graphs and data, and communicate mathematical reasoning clearly. This is assessed primarily through Proof/Reasoning Questions and Standard MCQs requiring justification, rather than as a separately scored domain.

9. Standard Question Formats

The following question formats may be used across topics, as indicated in each topic's Recommended Question Types field:

- Standard MCQ · Advanced MCQ · Numerical reasoning MCQ · Algebraic MCQ · Graph-based MCQ · Geometry MCQ
- Data interpretation · Probability question · Proof/reasoning question · Error detection · Statement evaluation
- Multi-condition problem · Multi-step problem · Optimization problem · Non-routine challenge · Word problem · Picture-based MCQ · Logical reasoning

10. Curriculum Boundary

Each track is deliberately bounded to its appropriate academic level. Class 9–10 exclude calculus, matrices, formal proof by induction, and advanced trigonometric identities. O-Level excludes calculus, matrices, and complex-number methods, while introducing formal circle theorems, sets, and rigorous (though not fully advanced) proof. A-Level introduces calculus, matrices, binomial distribution and 3D vectors as its genuinely advanced content, but deliberately excludes university-level mathematics not labelled as enrichment: multivariable calculus, formal differential equation solution techniques, complex numbers, rigorous epsilon-delta analysis, and Lagrange multipliers. Enrichment-labelled content (e.g. Diophantine-style puzzles, pigeonhole-style reasoning) remains at an accessible, competition-oriented level throughout.

Markhor Junior Mathematics — Aspirant Level — Class 9

Course Overview

Markhor Junior Mathematics — Aspirant Level — Class 9 marks the transition into full secondary mathematics. Students strengthen algebraic fluency (factorization, quadratic equations, simultaneous equations), are introduced to functions, coordinate geometry, right-triangle trigonometry and the Pythagorean theorem, and develop grouped statistics, tree-diagram probability and systematic counting. Structured algebraic and geometric proof, always/sometimes/never reasoning and multi-domain problem solving are woven throughout, building the secondary mathematics foundation for Class 10 and beyond.

Mathematical Domains & Topics

Number Systems & Number Theory

- Real Number System & Surds (Introductory)
- Indices & Laws of Indices
- Number Theory Reasoning & Proof-Like Problems

Algebra

- Algebraic Expansion & Factorization
- Algebraic Identities
- Algebraic Fractions (Introductory)
- Simultaneous Linear Equations
- Quadratic Equations — Factorization Method
- Quadratic Equations — Formula & Completing the Square

Exponentials & Logarithms

- Introduction to Exponential Expressions & Growth

Functions

- Function Notation, Domain & Range (Introductory)
- Linear & Quadratic Functions — Graphs

Equations & Inequalities

- Linear Inequalities
- Quadratic Equations — Word Problems

Sequences & Series

- Arithmetic Sequences — nth Term & Series
- Geometric Sequences (Introductory)

Euclidean Geometry

- Congruence & Similarity — Advanced Reasoning
- Pythagorean Theorem & Applications
- Circle Geometry — Chords & Arcs
- Circle Geometry — Tangents (Introductory)
- Polygon & Angle Proofs
- Geometric Proof — Multi-Step Reasoning

Coordinate Geometry

- Distance, Midpoint & Gradient
- Equation of a Straight Line

- Parallel & Perpendicular Lines

Mensuration

- Surface Area & Volume of Prisms and Pyramids
- Surface Area & Volume of Cylinders, Cones & Spheres
- Similar Figures — Area & Volume Scale Factors

Trigonometry

- Right-Triangle Trigonometry — Sine, Cosine, Tangent
- Angles of Elevation & Depression
- Bearings

Statistics

- Grouped Data & Histograms
- Mean, Median & Mode for Grouped Data
- Cumulative Frequency & Quartiles

Probability

- Tree Diagrams & Combined Events
- Mutually Exclusive & Independent Events

Combinatorics & Counting

- Fundamental Counting Principle & Organized Counting

Mathematical Logic, Proof & Reasoning

- Always, Sometimes or Never — Secondary Level
- Algebraic & Geometric Proof (Introductory)

Problem Solving & Mathematical Modelling

- Multi-Step Problem Solving Across Domains
- Mathematical Modelling — Real-World Applications
- Non-Routine Reasoning Problems

Detailed Topic-by-Topic Curriculum — Class 9

Domain: Number Systems & Number Theory

1. Real Number System & Surds (Introductory)

Topic Code	C9-NT-01
Domain	Number Systems & Number Theory
Subtopics	Rational vs irrational numbers • Simplifying simple surds • Adding/subtracting like surds
Concept Description	Students classify numbers within the real number system and simplify and combine simple surd expressions.
Learning Outcomes	Students can classify a number within the real number system and simplify a simple surd expression.
Skills Developed	Number classification, Surd simplification, Reasoning
Prerequisites	Pioneer Level rational number and square root concepts.
Foundation (L1)	Simplify a surd such as √50 to its simplest form.
Advanced (L2)	Add or subtract two like surds after simplification.
Challenge (L3)	Determine whether a given expression involving surds is rational or irrational, with justification.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Numerical reasoning MCQ
Question Bank Boundary — Should Test	Classification of numbers; simplifying and combining like surds
Question Bank Boundary — Should NOT Test	Rationalizing denominators (see Class 10)

2. Indices & Laws of Indices

Topic Code	C9-NT-02
Domain	Number Systems & Number Theory
Subtopics	Laws of indices • Zero and negative indices • Standard form (introductory)
Concept Description	Students apply the laws of indices, including zero and negative indices, and express numbers in standard form.
Learning Outcomes	Students can simplify an expression using the laws of indices and convert between standard and ordinary form.
Skills Developed	Index laws, Procedural fluency, Representation
Prerequisites	Pioneer Level exponents and powers.
Foundation (L1)	Apply a single law of indices to simplify an expression.
Advanced (L2)	Simplify an expression combining two or more index laws, including negative indices.
Challenge (L3)	Solve an equation where the unknown appears as an exponent, using index law reasoning.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number

Question Bank Boundary — Should Test	Laws of indices including zero, negative and simple fractional cases; standard form
Question Bank Boundary — Should NOT Test	Solving general exponential equations requiring logarithms (see Exponentials & Logarithms)

3. Number Theory Reasoning & Proof-Like Problems

Topic Code	C9-NT-03
Domain	Number Systems & Number Theory
Subtopics	Divisibility reasoning • Odd/even and parity arguments • Simple proof-like number arguments
Concept Description	Students construct simple proof-like arguments about number properties, such as parity and divisibility.
Learning Outcomes	Students can construct a short justified argument about a number property using algebraic representation.
Skills Developed	Proof-like reasoning, Algebraic representation, Justification
Prerequisites	Pioneer Level number theory and always/sometimes/never reasoning.
Foundation (L1)	Test a number-property claim using several numerical examples.
Advanced (L2)	Represent even/odd numbers algebraically (e.g. 2n, 2n+1) to justify a claim.
Challenge (L3)	Construct a complete proof-like argument for a divisibility or parity claim using algebraic representation.
Visual Priority	Low
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Parity and divisibility arguments using algebraic representation
Question Bank Boundary — Should NOT Test	Formal modular arithmetic notation

Domain: Algebra

1. Algebraic Expansion & Factorization

Topic Code	C9-AL-01
Domain	Algebra
Subtopics	Expanding multiple brackets • Factorizing by common factor and grouping • Factorizing quadratic trinomials
Concept Description	Students expand expressions involving multiple brackets and factorize expressions, including quadratic trinomials.
Learning Outcomes	Students can expand a multi-bracket expression and factorize a quadratic trinomial.
Skills Developed	Algebraic manipulation, Factorization, Procedural fluency
Prerequisites	Pioneer Level bracket expansion and simple factorization.
Foundation (L1)	Expand two binomials, e.g. (x+2)(x+5).
Advanced (L2)	Factorize a quadratic trinomial with a leading coefficient of 1.

Challenge (L3)	Factorize a quadratic trinomial with a leading coefficient greater than 1, or by grouping four terms.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Expansion of two binomials; factorization of quadratic trinomials
Question Bank Boundary — Should NOT Test	Factorization requiring the quadratic formula

2. Algebraic Identities

Topic Code	C9-AL-02
Domain	Algebra
Subtopics	$(a+b)^2$ and $(a-b)^2$ • Difference of two squares • Applying identities to simplify calculations
Concept Description	Students apply standard algebraic identities to expand, factorize and simplify expressions and calculations.
Learning Outcomes	Students can apply a standard algebraic identity to expand, factorize, or simplify a numerical calculation.
Skills Developed	Algebraic identities, Pattern recognition, Efficient calculation
Prerequisites	Pioneer Level introductory algebraic identities.
Foundation (L1)	Expand $(a+b)^2$ or $(a-b)^2$ using the identity.
Advanced (L2)	Factorize an expression using the difference of two squares.
Challenge (L3)	Use an identity to efficiently evaluate a numerical expression without direct calculation (e.g. $102^2 - 98^2$).
Visual Priority	Low
Recommended Question Types	Standard MCQ, Mental maths question
Question Bank Boundary — Should Test	$(a\pm b)^2$ and a^2-b^2 identities and their applications
Question Bank Boundary — Should NOT Test	Cubic identities (see Class 10 advanced factorization)

3. Algebraic Fractions (Introductory)

Topic Code	C9-AL-03
Domain	Algebra
Subtopics	Simplifying algebraic fractions • Multiplying/dividing algebraic fractions • Adding/subtracting with common denominators
Concept Description	Students simplify algebraic fractions and perform operations with them, starting with common denominators.
Learning Outcomes	Students can simplify an algebraic fraction and add or subtract two algebraic fractions with a common denominator.
Skills Developed	Algebraic manipulation, Fraction operations, Simplification
Prerequisites	Algebraic Expansion & Factorization (this track).

Foundation (L1)	Simplify an algebraic fraction by cancelling a common factor.
Advanced (L2)	Multiply or divide two algebraic fractions.
Challenge (L3)	Add or subtract two algebraic fractions with different but related denominators.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Simplifying and operating on algebraic fractions with simple denominators
Question Bank Boundary — Should NOT Test	Algebraic fractions requiring partial fraction decomposition

4. Simultaneous Linear Equations

Topic Code	C9-AL-04
Domain	Algebra
Subtopics	Solving by substitution • Solving by elimination • Word problems leading to simultaneous equations
Concept Description	Students solve pairs of simultaneous linear equations using substitution and elimination, including from word problems.
Learning Outcomes	Students can solve a pair of simultaneous linear equations and interpret the solution in context.
Skills Developed	Algebraic manipulation, Problem solving, Interpretation
Prerequisites	Pioneer Level linear equations in one variable.
Foundation (L1)	Solve a simple pair of simultaneous equations by substitution.
Advanced (L2)	Solve a pair of simultaneous equations by elimination, including scaling one equation first.
Challenge (L3)	Set up and solve simultaneous equations from an unfamiliar word problem.
Visual Priority	Low
Recommended Question Types	Missing number, Word problem
Question Bank Boundary — Should Test	Simultaneous linear equations in two variables
Question Bank Boundary — Should NOT Test	Simultaneous equations in three variables (see O-Level)

5. Quadratic Equations — Factorization Method

Topic Code	C9-AL-05
Domain	Algebra
Subtopics	Solving by factorization • Zero product property • Forming a quadratic from its roots
Concept Description	Students solve quadratic equations by factorization and use the zero product property to interpret solutions.
Learning Outcomes	Students can solve a quadratic equation by factorization and verify the solutions.
Skills Developed	Algebraic manipulation, Factorization, Verification
Prerequisites	Algebraic Expansion & Factorization (this track).

Foundation (L1)	Solve a quadratic equation that factorizes directly.
Advanced (L2)	Solve a quadratic equation requiring rearrangement into standard form first.
Challenge (L3)	Form a quadratic equation given its two roots and verify by expansion.
Visual Priority	Low
Recommended Question Types	Missing number, Standard MCQ
Question Bank Boundary — Should Test	Quadratics that factorize with integer or simple rational roots
Question Bank Boundary — Should NOT Test	Quadratics requiring the formula or completing the square (separate topic)

6. Quadratic Equations — Formula & Completing the Square

Topic Code	C9-AL-06
Domain	Algebra
Subtopics	The quadratic formula • Completing the square • Choosing an appropriate method
Concept Description	Students solve quadratic equations using the quadratic formula and by completing the square.
Learning Outcomes	Students can solve a quadratic equation using the formula or by completing the square, choosing appropriately.
Skills Developed	Algebraic manipulation, Procedural fluency, Strategy selection
Prerequisites	Quadratic Equations — Factorization Method (this track).
Foundation (L1)	Solve a quadratic equation using the quadratic formula.
Advanced (L2)	Complete the square for a quadratic expression and use it to solve the equation.
Challenge (L3)	Choose the most efficient method (factorization, formula, or completing the square) for an unfamiliar quadratic.
Visual Priority	Low
Recommended Question Types	Missing number, Standard MCQ
Question Bank Boundary — Should Test	The quadratic formula and completing the square for any quadratic
Question Bank Boundary — Should NOT Test	Formal discriminant analysis of root nature (see Class 10)

Domain: Exponentials & Logarithms

1. Introduction to Exponential Expressions & Growth

Topic Code	C9-EL-01
Domain	Exponentials & Logarithms
Subtopics	Exponential expressions • Simple exponential growth/decay contexts • Comparing linear and exponential growth
Concept Description	Students evaluate simple exponential expressions and compare linear versus exponential growth in real-life contexts.

Learning Outcomes	Students can evaluate an exponential expression and describe how a quantity grows or decays exponentially.
Skills Developed	Exponential reasoning, Application, Comparison
Prerequisites	Indices & Laws of Indices (this track).
Foundation (L1)	Evaluate a simple exponential expression for a given value.
Advanced (L2)	Compare the growth of a linear and an exponential model over several steps.
Challenge (L3)	Solve a real-life problem involving repeated exponential growth or decay (e.g. population, depreciation).
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Evaluating exponential expressions; qualitative growth/decay comparison
Question Bank Boundary — Should NOT Test	Solving exponential equations algebraically (see Class 10)

Domain: Functions

1. Function Notation, Domain & Range (Introductory)

Topic Code	C9-FN-01
Domain	Functions
Subtopics	Function notation f(x) • Evaluating functions • Domain and range (introductory)
Concept Description	Students use function notation to evaluate functions and identify their domain and range in simple cases.
Learning Outcomes	Students can evaluate a function for a given input and state its domain and range for a simple function.
Skills Developed	Function notation, Evaluation, Classification
Prerequisites	Algebraic Expressions & Substitution (Pioneer Level).
Foundation (L1)	Evaluate f(x) for a given value of x.
Advanced (L2)	State the domain and range of a simple linear or quadratic function.
Challenge (L3)	Determine the domain of a function involving a simple restriction (e.g. a denominator that cannot be zero).
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Function notation, evaluation, and domain/range for linear and quadratic functions
Question Bank Boundary — Should NOT Test	Composite or inverse functions (see Class 10)

2. Linear & Quadratic Functions — Graphs

Topic Code	C9-FN-02

Domain	Functions
Subtopics	Sketching linear graphs • Sketching quadratic graphs • Key features (intercepts, vertex, axis of symmetry)
Concept Description	Students sketch linear and quadratic function graphs, identifying key features such as intercepts and the vertex.
Learning Outcomes	Students can sketch a linear or quadratic graph and identify its key features.
Skills Developed	Graphing, Interpretation, Pattern recognition
Prerequisites	Function Notation, Domain & Range (this track).
Foundation (L1)	Sketch a linear graph from its equation.
Advanced (L2)	Sketch a quadratic graph, identifying the vertex and axis of symmetry.
Challenge (L3)	Determine the equation of a quadratic graph from its key features (roots and one other point).
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Graph-based MCQ
Question Bank Boundary — Should Test	Sketching and interpreting linear and quadratic graphs
Question Bank Boundary — Should NOT Test	Graph transformations (see Class 10)

Domain: Equations & Inequalities

1. Linear Inequalities

Topic Code	C9-EQ-01
Domain	Equations & Inequalities
Subtopics	Solving linear inequalities • Compound inequalities • Representing solutions on a number line
Concept Description	Students solve linear and compound inequalities and represent their solutions on a number line.
Learning Outcomes	Students can solve a linear or compound inequality and represent the solution set correctly.
Skills Developed	Algebraic manipulation, Representation, Reasoning
Prerequisites	Pioneer Level linear inequalities.
Foundation (L1)	Solve a one-step linear inequality.
Advanced (L2)	Solve a compound inequality (e.g. $-3 < 2x+1 \leq 7$).
Challenge (L3)	Solve a word problem requiring the setup of a linear inequality with a real-life constraint.
Visual Priority	Medium
Recommended Question Types	Picture-based MCQ, Word problem
Question Bank Boundary — Should Test	Linear and compound inequalities in one variable
Question Bank Boundary — Should NOT Test	Quadratic inequalities (see Class 10)

2. Quadratic Equations — Word Problems

Topic Code	C9-EQ-02
Domain	Equations & Inequalities
Subtopics	Translating word problems into quadratics • Solving and interpreting solutions • Rejecting invalid solutions in context
Concept Description	Students translate real-life word problems into quadratic equations, solve them, and interpret solutions in context.
Learning Outcomes	Students can set up and solve a quadratic equation from a word problem, rejecting solutions that do not fit the context.
Skills Developed	Problem solving, Algebraic modelling, Interpretation
Prerequisites	Quadratic Equations — Factorization Method (this track).
Foundation (L1)	Set up and solve a simple quadratic word problem (e.g. area of a rectangle).
Advanced (L2)	Set up and solve a quadratic word problem requiring rejection of a negative or invalid solution.
Challenge (L3)	Solve a multi-step quadratic word problem with an unfamiliar or layered context.
Visual Priority	Medium
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Quadratic word problems from geometry, motion or number contexts
Question Bank Boundary — Should NOT Test	Word problems requiring simultaneous quadratic and linear systems

Domain: Sequences & Series

1. Arithmetic Sequences — nth Term & Series

Topic Code	C9-SQ-01
Domain	Sequences & Series
Subtopics	nth term formula • Sum of an arithmetic series • Applications
Concept Description	Students derive and apply the nth-term formula for arithmetic sequences and calculate the sum of an arithmetic series.
Learning Outcomes	Students can find the nth term of an arithmetic sequence and calculate the sum of a given number of terms.
Skills Developed	Formula application, Algebraic reasoning, Application
Prerequisites	Pioneer Level arithmetic sequences.
Foundation (L1)	Find the nth term of an arithmetic sequence using the formula.
Advanced (L2)	Calculate the sum of the first n terms of an arithmetic series.
Challenge (L3)	Solve a problem requiring both the nth term and sum formulas together in an unfamiliar context.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	nth term and sum formulas for arithmetic sequences

Question Bank Boundary — Should NOT Test	Geometric series (separate topic)

2. Geometric Sequences (Introductory)

Topic Code	C9-SQ-02
Domain	Sequences & Series
Subtopics	Common ratio • nth term of a geometric sequence • Distinguishing arithmetic from geometric sequences
Concept Description	Students identify the common ratio of a geometric sequence and find its nth term.
Learning Outcomes	Students can find the nth term of a geometric sequence given its first term and common ratio.
Skills Developed	Pattern recognition, Formula application, Classification
Prerequisites	Arithmetic Sequences — nth Term & Series (this track).
Foundation (L1)	Identify the common ratio of a geometric sequence.
Advanced (L2)	Find the nth term of a geometric sequence.
Challenge (L3)	Determine whether a given sequence is arithmetic, geometric or neither, and justify the answer.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	nth term of geometric sequences with whole-number or simple fractional ratios
Question Bank Boundary — Should NOT Test	Sum of a geometric series (see Class 10)

Domain: Euclidean Geometry

1. Congruence & Similarity — Advanced Reasoning

Topic Code	C9-GE-01
Domain	Euclidean Geometry
Subtopics	Congruence conditions (review and extension) • Similar triangles in complex figures • Using similarity to find missing lengths
Concept Description	Students apply congruence and similarity conditions to more complex figures, including overlapping triangles.
Learning Outcomes	Students can identify congruent or similar triangles within a complex figure and use this to find missing values.
Skills Developed	Geometric reasoning, Deduction, Application
Prerequisites	Pioneer Level congruence and similarity.
Foundation (L1)	Identify a pair of congruent or similar triangles in a simple diagram.
Advanced (L2)	Use similarity to find a missing length in a diagram with overlapping triangles.
Challenge (L3)	Solve a multi-step problem requiring both congruence and similarity reasoning in the same diagram.
Visual Priority	High

Recommended Question Types	Geometry MCQ, Proof/reasoning question
Question Bank Boundary — Should Test	Congruence and similarity in complex or overlapping figures
Question Bank Boundary — Should NOT Test	Formal two-column proofs (see O-Level)

2. Pythagorean Theorem & Applications

Topic Code	C9-GE-02
Domain	Euclidean Geometry
Subtopics	The Pythagorean theorem • Finding a missing side • Real-life and multi-step applications
Concept Description	Students apply the Pythagorean theorem to find missing sides and solve real-life and multi-step problems.
Learning Outcomes	Students can apply the Pythagorean theorem to find a missing side and solve a related real-life problem.
Skills Developed	Formula application, Problem solving, Spatial reasoning
Prerequisites	Pioneer Level triangle properties.
Foundation (L1)	Find the hypotenuse of a right triangle given the two shorter sides.
Advanced (L2)	Find a missing shorter side of a right triangle given the hypotenuse.
Challenge (L3)	Solve a multi-step real-life problem requiring the Pythagorean theorem combined with another skill (e.g. coordinate distance).
Visual Priority	High
Recommended Question Types	Geometry MCQ, Word problem
Question Bank Boundary — Should Test	The Pythagorean theorem and its converse in 2D contexts
Question Bank Boundary — Should NOT Test	Three-dimensional Pythagorean applications (see O-Level)

3. Circle Geometry — Chords & Arcs

Topic Code	C9-GE-03
Domain	Euclidean Geometry
Subtopics	Chord properties • Arc-angle relationships • Perpendicular from centre to chord
Concept Description	Students apply chord and arc properties of circles, including the perpendicular bisector property.
Learning Outcomes	Students can use chord and arc properties to find a missing length or angle in a circle diagram.
Skills Developed	Geometric reasoning, Circle properties, Application
Prerequisites	Pioneer Level circle terminology.
Foundation (L1)	Identify a chord, arc and central angle in a circle diagram.
Advanced (L2)	Use the property that equal chords subtend equal arcs to find a missing value.
Challenge (L3)	Use the perpendicular-from-centre-to-chord property in a multi-step problem.
Visual Priority	High

Recommended Question Types	Geometry MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Chord and arc properties within basic circle geometry
Question Bank Boundary — Should NOT Test	Cyclic quadrilateral or tangent-chord theorems (see Class 10/O-Level)

4. Circle Geometry — Tangents (Introductory)

Topic Code	C9-GE-04
Domain	Euclidean Geometry
Subtopics	Tangent properties • Tangent perpendicular to radius • Two tangents from an external point
Concept Description	Students apply basic tangent properties, including the perpendicularity of a tangent to the radius at the point of contact.
Learning Outcomes	Students can use tangent properties to find a missing length or angle involving a tangent to a circle.
Skills Developed	Geometric reasoning, Circle properties, Application
Prerequisites	Circle Geometry — Chords & Arcs (this track).
Foundation (L1)	Identify a tangent line to a circle and state its key property.
Advanced (L2)	Find a missing angle using the tangent-radius perpendicularity property.
Challenge (L3)	Solve a problem involving two tangents drawn from the same external point.
Visual Priority	High
Recommended Question Types	Geometry MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Basic tangent properties and the two-tangent property
Question Bank Boundary — Should NOT Test	Tangent-chord angle theorem (see Class 10)

5. Polygon & Angle Proofs

Topic Code	C9-GE-05
Domain	Euclidean Geometry
Subtopics	Justifying polygon angle facts • Multi-step angle proofs • Combining polygon and parallel-line facts
Concept Description	Students construct justified, multi-step arguments combining polygon angle facts with parallel-line properties.
Learning Outcomes	Students can construct a justified, multi-step argument to find a missing angle, stating the properties used.
Skills Developed	Geometric reasoning, Justification, Multi-step problem solving
Prerequisites	Pioneer Level polygon angle sums and parallel-line properties.
Foundation (L1)	Justify a single angle fact in a polygon diagram.
Advanced (L2)	Combine two angle facts to justify a missing angle in a multi-step diagram.
Challenge (L3)	Construct a full justified argument for an angle in an unfamiliar, multi-step diagram.

Visual Priority	High
Recommended Question Types	Proof/reasoning question, Geometry MCQ
Question Bank Boundary — Should Test	Justified multi-step angle reasoning combining known facts
Question Bank Boundary — Should NOT Test	Formal axiomatic proof requiring theorem numbering

6. Geometric Proof — Multi-Step Reasoning

Topic Code	C9-GE-06
Domain	Euclidean Geometry
Subtopics	Structuring a geometric argument • Combining several properties • Communicating a complete justification
Concept Description	Students structure and communicate complete geometric arguments combining several properties in sequence.
Learning Outcomes	Students can construct and clearly communicate a complete multi-step geometric argument.
Skills Developed	Geometric reasoning, Communication, Justification
Prerequisites	Polygon & Angle Proofs (this track).
Foundation (L1)	State the single property that justifies one step of a given argument.
Advanced (L2)	Complete a partially-given multi-step geometric argument.
Challenge (L3)	Construct an original multi-step geometric argument from a new diagram, communicating each step clearly.
Visual Priority	Medium
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Multi-step justified geometric arguments using Class 9 properties
Question Bank Boundary — Should NOT Test	Formal two-column or axiomatic proof format

Domain: Coordinate Geometry

1. Distance, Midpoint & Gradient

Topic Code	C9-CG-01
Domain	Coordinate Geometry
Subtopics	Distance formula • Midpoint formula • Gradient formula
Concept Description	Students calculate the distance between two points, the midpoint of a segment, and the gradient of a line.
Learning Outcomes	Students can calculate the distance, midpoint or gradient given the coordinates of two points.
Skills Developed	Formula application, Coordinate reasoning, Procedural fluency
Prerequisites	Pioneer Level coordinate plane and gradient concept.
Foundation (L1)	Calculate the distance between two points using the distance formula.

Advanced (L2)	Calculate the midpoint and gradient of a segment given its endpoints.
Challenge (L3)	Solve a multi-step problem requiring distance, midpoint and gradient together (e.g. classifying a triangle).
Visual Priority	High
Recommended Question Types	Standard MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Distance, midpoint and gradient formulas for any two points
Question Bank Boundary — Should NOT Test	Equation of a circle (see later topics)

2. Equation of a Straight Line

Topic Code	C9-CG-02
Domain	Coordinate Geometry
Subtopics	Slope-intercept form • Point-gradient form • Finding the equation from two points
Concept Description	Students find the equation of a straight line from given information such as gradient, a point, or two points.
Learning Outcomes	Students can find the equation of a straight line given sufficient information about it.
Skills Developed	Formula application, Algebraic manipulation, Coordinate reasoning
Prerequisites	Distance, Midpoint & Gradient (this track).
Foundation (L1)	Write the equation of a line given its gradient and y-intercept.
Advanced (L2)	Find the equation of a line given its gradient and one point on the line.
Challenge (L3)	Find the equation of a line given two points, then use it to solve a related problem.
Visual Priority	High
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Finding the equation of a straight line in slope-intercept or point-gradient form
Question Bank Boundary — Should NOT Test	Equations of curves other than straight lines

3. Parallel & Perpendicular Lines

Topic Code	C9-CG-03
Domain	Coordinate Geometry
Subtopics	Gradient condition for parallel lines • Gradient condition for perpendicular lines • Applications and proofs
Concept Description	Students use the gradient conditions for parallel and perpendicular lines to solve problems and simple coordinate proofs.
Learning Outcomes	Students can determine whether two lines are parallel or perpendicular and find the equation of a line satisfying a given condition.
Skills Developed	Coordinate reasoning, Algebraic manipulation, Proof
Prerequisites	Equation of a Straight Line (this track).

Foundation (L1)	Determine whether two given lines are parallel.
Advanced (L2)	Find the equation of a line parallel or perpendicular to a given line, through a given point.
Challenge (L3)	Use parallel/perpendicular conditions in a simple coordinate proof (e.g. showing a triangle is right-angled).
Visual Priority	High
Recommended Question Types	Standard MCQ, Proof/reasoning question
Question Bank Boundary — Should Test	Gradient conditions for parallel and perpendicular lines and their application
Question Bank Boundary — Should NOT Test	Equation of a circle or tangent lines (see later tracks)

Domain: Mensuration

1. Surface Area & Volume of Prisms and Pyramids

Topic Code	C9-MN-01
Domain	Mensuration
Subtopics	Surface area of prisms • Volume of prisms • Volume of pyramids
Concept Description	Students calculate the surface area of prisms and the volume of prisms and pyramids.
Learning Outcomes	Students can calculate the surface area of a prism and the volume of a prism or pyramid.
Skills Developed	Formula application, Spatial reasoning, Multi-step calculation
Prerequisites	Pioneer Level surface area and volume of cubes/cuboids.
Foundation (L1)	Calculate the volume of a triangular prism given its dimensions.
Advanced (L2)	Calculate the surface area of a prism using its net.
Challenge (L3)	Calculate the volume of a pyramid and solve a related real-life problem.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Word problem
Question Bank Boundary — Should Test	Surface area and volume of prisms; volume of pyramids
Question Bank Boundary — Should NOT Test	Curved solids (see next topic)

2. Surface Area & Volume of Cylinders, Cones & Spheres

Topic Code	C9-MN-02
Domain	Mensuration
Subtopics	Surface area and volume of cylinders • Surface area and volume of cones • Volume of spheres
Concept Description	Students calculate the surface area and volume of cylinders, cones and spheres using standard formulas.
Learning Outcomes	Students can calculate the surface area or volume of a cylinder, cone or sphere.
Skills Developed	Formula application, Spatial reasoning, Multi-step calculation

Prerequisites	Surface Area & Volume of Prisms and Pyramids (this track).
Foundation (L1)	Calculate the volume of a cylinder given its radius and height.
Advanced (L2)	Calculate the surface area of a cone given its radius and slant height.
Challenge (L3)	Solve a real-life problem involving the volume or surface area of a composite solid including a curved solid.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Word problem
Question Bank Boundary — Should Test	Surface area and volume formulas for cylinders, cones and spheres
Question Bank Boundary — Should NOT Test	Derivation of the formulas using calculus

3. Similar Figures — Area & Volume Scale Factors

Topic Code	C9-MN-03
Domain	Mensuration
Subtopics	Linear, area and volume scale factor relationships • Applications to similar solids • Real-life scale problems
Concept Description	Students apply the relationships between linear, area and volume scale factors for similar figures and solids.
Learning Outcomes	Students can use the relationship between linear, area and volume scale factors to solve a similarity problem.
Skills Developed	Proportional reasoning, Formula application, Problem solving
Prerequisites	Similar Triangles (Pioneer Level); Congruence & Similarity — Advanced Reasoning (this track).
Foundation (L1)	Given the linear scale factor, find the area scale factor between two similar figures.
Advanced (L2)	Given the area of one similar figure, find the area of another using the scale factor.
Challenge (L3)	Solve a multi-step real-life problem involving volume scale factor between similar solids.
Visual Priority	High
Recommended Question Types	Word problem, Standard MCQ
Question Bank Boundary — Should Test	Linear-area-volume scale factor relationships (k, k^2, k^3)
Question Bank Boundary — Should NOT Test	Scale factor problems requiring calculus-based reasoning

Domain: Trigonometry

1. Right-Triangle Trigonometry — Sine, Cosine, Tangent

Topic Code	C9-TR-01
Domain	Trigonometry
Subtopics	SOH-CAH-TOA • Finding a missing side • Finding a missing angle

Concept Description	Students use the sine, cosine and tangent ratios to find missing sides and angles in right triangles.
Learning Outcomes	Students can find a missing side or angle in a right triangle using an appropriate trigonometric ratio.
Skills Developed	Trigonometric reasoning, Formula application, Problem solving
Prerequisites	Pythagorean Theorem & Applications (this track).
Foundation (L1)	Find a missing side using sine, cosine or tangent, given an angle and one side.
Advanced (L2)	Find a missing angle using an inverse trigonometric ratio.
Challenge (L3)	Solve a multi-step right-triangle problem requiring more than one trigonometric ratio or the Pythagorean theorem together.
Visual Priority	High
Recommended Question Types	Geometry MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Right-triangle trigonometry for finding sides and angles
Question Bank Boundary — Should NOT Test	Sine rule or cosine rule for non-right triangles (see Class 10)

2. Angles of Elevation & Depression

Topic Code	C9-TR-02
Domain	Trigonometry
Subtopics	Defining elevation and depression • Real-life applications • Multi-step problems
Concept Description	Students apply right-triangle trigonometry to problems involving angles of elevation and depression.
Learning Outcomes	Students can solve a real-life problem involving an angle of elevation or depression.
Skills Developed	Trigonometric reasoning, Application, Spatial reasoning
Prerequisites	Right-Triangle Trigonometry — Sine, Cosine, Tangent (this track).
Foundation (L1)	Find a missing height or distance given an angle of elevation and a known distance.
Advanced (L2)	Find a missing angle of elevation or depression given the relevant sides.
Challenge (L3)	Solve a multi-step problem involving two angles of elevation/depression observed from different points.
Visual Priority	High
Recommended Question Types	Word problem, Picture-based MCQ
Question Bank Boundary — Should Test	Angle of elevation/depression problems using right-triangle trigonometry
Question Bank Boundary — Should NOT Test	Three-dimensional elevation/depression problems (see O-Level)

3. Bearings

Topic Code	C9-TR-03
Domain	Trigonometry

Subtopics	Three-figure bearings • Bearing problems using trigonometry • Back bearings
Concept Description	Students interpret and calculate three-figure bearings and use trigonometry to solve bearing problems.
Learning Outcomes	Students can interpret a bearing and use trigonometry to solve a problem involving distances and bearings.
Skills Developed	Trigonometric reasoning, Spatial reasoning, Application
Prerequisites	Right-Triangle Trigonometry — Sine, Cosine, Tangent (this track).
Foundation (L1)	State the three-figure bearing shown in a simple diagram.
Advanced (L2)	Find a missing distance or angle in a bearing problem using right-triangle trigonometry.
Challenge (L3)	Solve a multi-step bearing problem involving two or more legs of a journey.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Word problem
Question Bank Boundary — Should Test	Three-figure bearings solvable using right-triangle trigonometry
Question Bank Boundary — Should NOT Test	Bearing problems requiring the sine or cosine rule (see Class 10)

Domain: Statistics

1. Grouped Data & Histograms

Topic Code	C9-ST-01
Domain	Statistics
Subtopics	Grouped frequency tables • Class intervals • Constructing and reading histograms
Concept Description	Students organize continuous data into grouped frequency tables and construct and interpret histograms.
Learning Outcomes	Students can construct a grouped frequency table and a histogram with equal class widths.
Skills Developed	Data organization, Representation, Interpretation
Prerequisites	Pioneer Level data organization and representation.
Foundation (L1)	Complete a grouped frequency table from raw data.
Advanced (L2)	Construct a histogram with equal class widths from a grouped frequency table.
Challenge (L3)	Interpret a histogram to answer a question requiring combining information from more than one class interval.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Data interpretation
Question Bank Boundary — Should Test	Grouped frequency tables and histograms with equal class widths
Question Bank Boundary — Should NOT Test	Histograms with unequal class widths (see O-Level)

2. Mean, Median & Mode for Grouped Data

Topic Code	C9-ST-02
Domain	Statistics
Subtopics	Estimating the mean from grouped data • Modal class • Median class
Concept Description	Students estimate the mean of grouped data and identify the modal and median classes.
Learning Outcomes	Students can estimate the mean of grouped data and identify its modal and median classes.
Skills Developed	Data analysis, Estimation, Application
Prerequisites	Grouped Data & Histograms (this track).
Foundation (L1)	Identify the modal class of a grouped frequency table.
Advanced (L2)	Estimate the mean of grouped data using midpoints.
Challenge (L3)	Compare the estimated mean of two grouped data sets and justify which is more reliable.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Data interpretation
Question Bank Boundary — Should Test	Estimating the mean and finding modal/median classes for grouped data
Question Bank Boundary — Should NOT Test	Exact median calculation for grouped data (see cumulative frequency topic)

3. Cumulative Frequency & Quartiles

Topic Code	C9-ST-03
Domain	Statistics
Subtopics	Cumulative frequency tables • Estimating median and quartiles • Interquartile range
Concept Description	Students construct cumulative frequency tables and estimate the median, quartiles and interquartile range.
Learning Outcomes	Students can construct a cumulative frequency table and estimate the median and interquartile range.
Skills Developed	Data organization, Estimation, Application
Prerequisites	Mean, Median & Mode for Grouped Data (this track).
Foundation (L1)	Construct a cumulative frequency table from a grouped frequency table.
Advanced (L2)	Estimate the median from a cumulative frequency table.
Challenge (L3)	Estimate the interquartile range and use it to compare two data sets.
Visual Priority	High
Recommended Question Types	Data interpretation, Standard MCQ
Question Bank Boundary — Should Test	Cumulative frequency tables and estimation of median/quartiles from tables
Question Bank Boundary — Should NOT Test	Cumulative frequency curves (see Class 10)

Domain: Probability

1. Tree Diagrams & Combined Events

Topic Code	C9-PR-01
Domain	Probability
Subtopics	Constructing tree diagrams • Calculating combined probabilities • With and without replacement
Concept Description	Students construct tree diagrams to calculate the probability of combined events, with and without replacement.
Learning Outcomes	Students can construct a tree diagram and use it to calculate the probability of a combined event.
Skills Developed	Probability reasoning, Systematic representation, Application
Prerequisites	Pioneer Level probability as a fraction.
Foundation (L1)	Construct a tree diagram for a two-stage experiment with replacement.
Advanced (L2)	Construct a tree diagram for a two-stage experiment without replacement.
Challenge (L3)	Use a tree diagram to solve a multi-stage probability problem requiring several branches to be combined.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Tree diagrams for two- and three-stage experiments
Question Bank Boundary — Should NOT Test	Formal conditional probability notation P(A|B) (see Class 10)

2. Mutually Exclusive & Independent Events

Topic Code	C9-PR-02
Domain	Probability
Subtopics	Mutually exclusive events (addition rule) • Independent events (multiplication rule) • Distinguishing the two situations
Concept Description	Students apply the addition rule for mutually exclusive events and the multiplication rule for independent events.
Learning Outcomes	Students can determine whether events are mutually exclusive or independent and apply the appropriate rule.
Skills Developed	Probability reasoning, Classification, Application
Prerequisites	Tree Diagrams & Combined Events (this track).
Foundation (L1)	Apply the addition rule to find the probability of one of two mutually exclusive events.
Advanced (L2)	Apply the multiplication rule to find the probability of two independent events both occurring.
Challenge (L3)	Solve a problem requiring the student to first determine whether events are mutually exclusive, independent, or neither.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Addition rule for mutually exclusive events; multiplication rule for independent events
Question Bank Boundary — Should NOT Test	Conditional probability for dependent events (see Class 10)

Domain: Combinatorics & Counting

1. Fundamental Counting Principle & Organized Counting

Topic Code	C9-CO-01
Domain	Combinatorics & Counting
Subtopics	Multiplication principle • Organized listing for multi-stage problems • Counting with simple restrictions
Concept Description	Students apply the fundamental counting principle to multi-stage counting problems, including simple restrictions.
Learning Outcomes	Students can apply the fundamental counting principle to a multi-stage counting problem.
Skills Developed	Systematic thinking, Counting strategies, Problem solving
Prerequisites	Pioneer Level systematic counting.
Foundation (L1)	Apply the counting principle to a two-stage scenario.
Advanced (L2)	Apply the counting principle to a three- or four-stage scenario.
Challenge (L3)	Apply the counting principle to a scenario with a restriction (e.g. a specific item must/must not be included).
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Logical reasoning
Question Bank Boundary — Should Test	Multi-stage counting using the fundamental counting principle
Question Bank Boundary — Should NOT Test	Formal permutation/combination formulas (see Class 10)

Domain: Mathematical Logic, Proof & Reasoning

1. Always, Sometimes or Never — Secondary Level

Topic Code	C9-LR-01
Domain	Mathematical Logic, Proof & Reasoning
Subtopics	Testing algebraic and geometric statements • Finding counterexamples • Justifying general claims
Concept Description	Students test whether algebraic or geometric statements are always, sometimes, or never true, using secondary-level concepts.
Learning Outcomes	Students can determine whether a secondary-level mathematical statement is always, sometimes or never true, with justification.
Skills Developed	Logical reasoning, Counterexample construction, Justification
Prerequisites	Pioneer Level always/sometimes/never reasoning.
Foundation (L1)	Test a statement involving quadratics or geometry using one or two examples.
Advanced (L2)	Find a counterexample that disproves a claim involving Class 9 algebra or geometry.
Challenge (L3)	Justify why a Class 9-level statement is always true using a general algebraic or geometric argument.

Visual Priority	Low
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Always/sometimes/never reasoning using Class 9 algebra and geometry
Question Bank Boundary — Should NOT Test	Formal proof by contradiction (see A-Level)

2. Algebraic & Geometric Proof (Introductory)

Topic Code	C9-LR-02
Domain	Mathematical Logic, Proof & Reasoning
Subtopics	Structuring a simple proof • Algebraic proof of a number claim • Geometric proof of a simple claim
Concept Description	Students construct simple, structured proofs of algebraic and geometric claims using known facts.
Learning Outcomes	Students can construct a simple, clearly structured proof of an algebraic or geometric claim.
Skills Developed	Proof construction, Algebraic representation, Communication
Prerequisites	Always, Sometimes or Never — Secondary Level (this track).
Foundation (L1)	Complete a partially-given simple proof.
Advanced (L2)	Construct a short algebraic proof of a number claim (e.g. the sum of two consecutive integers).
Challenge (L3)	Construct a short geometric proof combining two or more known properties.
Visual Priority	Low
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Simple structured proofs using Class 9 algebra and geometry
Question Bank Boundary — Should NOT Test	Formal proof by induction or contradiction (see A-Level)

Domain: Problem Solving & Mathematical Modelling

1. Multi-Step Problem Solving Across Domains

Topic Code	C9-PS-01
Domain	Problem Solving & Mathematical Modelling
Subtopics	Problems combining several domains • Understand-Plan-Solve-Check approach • Real-life multi-domain contexts
Concept Description	Students solve multi-step problems combining two or more Class 9 mathematical domains.
Learning Outcomes	Students can plan, solve and check a multi-step problem combining several Class 9 domains.
Skills Developed	Problem solving, Multi-step reasoning, Self-checking
Prerequisites	Broad Class 9 topic base.
Foundation (L1)	Solve a two-domain problem with familiar numbers.
Advanced (L2)	Solve a three-step problem combining two or three domains.

Challenge (L3)	Solve a problem combining three or more domains with an unfamiliar context.
Visual Priority	Medium
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Multi-step, multi-domain problems built from Class 9 concepts
Question Bank Boundary — Should NOT Test	Problems requiring concepts beyond Class 9 scope

2. Mathematical Modelling — Real-World Applications

Topic Code	C9-PS-02
Domain	Problem Solving & Mathematical Modelling
Subtopics	Identifying variables and relationships • Building a simple model • Evaluating a model's reasonableness
Concept Description	Students build simple mathematical models of real-world situations and evaluate their reasonableness.
Learning Outcomes	Students can build a simple mathematical model of a real-world situation and comment on its limitations.
Skills Developed	Mathematical modelling, Critical thinking, Communication
Prerequisites	Broad Class 9 topic base.
Foundation (L1)	Identify the key variables in a described real-world situation.
Advanced (L2)	Build a simple equation or formula modelling a described situation.
Challenge (L3)	Evaluate the limitations or assumptions of a given simple model and suggest an improvement.
Visual Priority	Medium
Recommended Question Types	Word problem, Standard MCQ
Question Bank Boundary — Should Test	Simple modelling using Class 9 algebra, geometry or statistics
Question Bank Boundary — Should NOT Test	Modelling requiring calculus or advanced statistics

3. Non-Routine Reasoning Problems

Topic Code	C9-PS-03
Domain	Problem Solving & Mathematical Modelling
Subtopics	Unfamiliar problem types • Strategy selection • Competition-style reasoning
Concept Description	Students apply strategic, flexible thinking to unfamiliar, competition-style problems built from Class 9 concepts.
Learning Outcomes	Students can approach an unfamiliar problem strategically, trying more than one approach if needed.
Skills Developed	Non-routine problem solving, Strategic thinking, Perseverance
Prerequisites	Broad Class 9 topic base.
Foundation (L1)	Solve a non-routine problem with a guided first step.

Advanced (L2)	Solve a non-routine problem combining two or three known Class 9 concepts.
Challenge (L3)	Solve a genuinely unfamiliar, multi-condition problem requiring an elegant or efficient solution.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Logical reasoning
Question Bank Boundary — Should Test	Non-routine problems built from Class 9 concepts only
Question Bank Boundary — Should NOT Test	Problems requiring concepts beyond Class 9 scope

Markhor Junior Mathematics — Aspirant Level — Class 10

Course Overview

Markhor Junior Mathematics — Aspirant Level — Class 10 develops advanced secondary mathematics and analytical thinking. Students extend algebra to the discriminant, quadratic inequalities and absolute value; are introduced to exponential and logarithmic equations, composite and inverse functions, and graph transformations; develop the sine rule, cosine rule and trigonometric graphs; and begin cumulative frequency curves, standard deviation, conditional probability, permutations/combinations and introductory vectors. Multi-step analytical problem solving and mathematical modelling of growth and rates are emphasised throughout, preparing students for the increased rigor of O-Level.

Mathematical Domains & Topics

Number Systems & Number Theory

- Surds — Simplification & Rationalizing
- Indices — Fractional & Negative Indices
- Number Theory — Diophantine-Style Problems

Algebra

- Algebraic Identities — Advanced Expansion/Factorization
- Algebraic Fractions — Operations & Simplification
- Simultaneous Equations — Linear & Quadratic
- Quadratic Equations — Discriminant & Nature of Roots
- Quadratic Inequalities
- Absolute Value Equations & Inequalities (Introductory)

Exponentials & Logarithms

- Exponential Equations
- Introduction to Logarithms & Laws of Logarithms

Functions

- Composite Functions
- Inverse Functions (Introductory)
- Graph Transformations — Translations & Reflections

Equations & Inequalities

- Rational Equations (Introductory)
- Radical Equations (Introductory)

Sequences & Series

- Arithmetic Series — Sum Formula
- Geometric Series — Sum Formula
- Sequence & Series Applications

Euclidean Geometry

- Circle Geometry — Cyclic Quadrilaterals
- Circle Geometry — Tangent-Chord Angle
- Advanced Similarity & Area Ratios
- Multi-Step Geometric Proof
- Constructions & Loci (Introductory)

Coordinate Geometry

- Equation of a Circle (Introductory)
- Coordinate Geometry Proofs
- Geometric Loci on the Coordinate Plane

Mensuration

- Composite Solids — Advanced Problems
- Arc Length & Sector Area

Trigonometry

- Sine Rule
- Cosine Rule
- Area of a Triangle Using Trigonometry
- Trigonometric Graphs (Introductory)

Statistics

- Cumulative Frequency Curves & Median Estimation
- Variance & Standard Deviation (Introductory)
- Comparing Distributions

Probability

- Conditional Probability (Introductory)
- Venn Diagrams & Set-Based Probability

Combinatorics & Counting

- Permutations (Introductory)
- Combinations (Introductory)

Vectors

- Vector Notation, Magnitude & Direction
- Vector Addition & Position Vectors

Mathematical Logic, Proof & Reasoning

- Direct & Indirect Reasoning
- Divisibility & Algebraic Proof

Problem Solving & Mathematical Modelling

- Multi-Step Analytical Problem Solving
- Mathematical Modelling — Growth & Rates

Detailed Topic-by-Topic Curriculum — Class 10

Domain: Number Systems & Number Theory

1. Surds — Simplification & Rationalizing

Topic Code	C10-NT-01
Domain	Number Systems & Number Theory
Subtopics	Simplifying complex surds • Multiplying/dividing surds • Rationalizing a denominator
Concept Description	Students simplify more complex surd expressions and rationalize denominators involving surds.
Learning Outcomes	Students can simplify a surd expression involving multiplication or division, and rationalize a simple denominator.
Skills Developed	Surd manipulation, Procedural fluency, Algebraic reasoning
Prerequisites	Real Number System & Surds (Introductory) — Class 9.
Foundation (L1)	Multiply two surds and simplify the result.
Advanced (L2)	Rationalize a denominator of the form a/√b.
Challenge (L3)	Rationalize a denominator involving a binomial surd expression (e.g. a/(√b + c)).
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Simplifying, multiplying/dividing surds; rationalizing monomial and binomial surd denominators
Question Bank Boundary — Should NOT Test	Surd equations requiring squaring both sides repeatedly

2. Indices — Fractional & Negative Indices

Topic Code	C10-NT-02
Domain	Number Systems & Number Theory
Subtopics	Fractional indices and roots • Combining fractional and negative indices • Simplifying complex index expressions
Concept Description	Students interpret and apply fractional and negative indices, combining index laws in more complex expressions.
Learning Outcomes	Students can simplify an expression involving fractional and negative indices.
Skills Developed	Index laws, Procedural fluency, Algebraic reasoning
Prerequisites	Indices & Laws of Indices — Class 9.
Foundation (L1)	Evaluate an expression with a simple fractional index (e.g. 8^(1/3)).
Advanced (L2)	Simplify an expression combining fractional and negative indices.
Challenge (L3)	Solve an equation where the unknown appears as a fractional or negative exponent.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Fractional and negative indices, including combined expressions

Question Bank Boundary — Should NOT Test	Solving general exponential equations requiring logarithms (see Exponentials & Logarithms)

3. Number Theory — Diophantine-Style Problems

Topic Code	C10-NT-03
Domain	Number Systems & Number Theory
Subtopics	Integer-solution equations • Constraint-based reasoning • Systematic search strategies
Concept Description	Students solve simple equations restricted to integer solutions, using constraint-based and systematic reasoning.
Learning Outcomes	Students can find all integer solutions to a simple equation with a given constraint.
Skills Developed	Number theory, Systematic reasoning, Problem solving
Prerequisites	Number Theory Reasoning & Proof-Like Problems — Class 9.
Foundation (L1)	Find integer solutions to a simple linear equation with a stated range constraint.
Advanced (L2)	Find all integer pairs satisfying a simple two-variable equation within given bounds.
Challenge (L3)	Solve a competition-style Diophantine-style puzzle requiring systematic elimination of cases.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Logical reasoning
Question Bank Boundary — Should Test	Simple integer-solution problems solvable by systematic search
Question Bank Boundary — Should NOT Test	Formal Diophantine equation theory (e.g. Bézout's identity)

Domain: Algebra

1. Algebraic Identities — Advanced Expansion/Factorization

Topic Code	C10-AL-01
Domain	Algebra
Subtopics	Sum and difference of cubes (introductory) • Expanding three binomials • Factorizing using combined identities
Concept Description	Students expand and factorize more advanced algebraic expressions, including an introduction to cube identities.
Learning Outcomes	Students can expand an expression involving three factors and factorize using a combination of identities.
Skills Developed	Algebraic manipulation, Factorization, Pattern recognition
Prerequisites	Algebraic Identities — Class 9.
Foundation (L1)	Expand a product of three simple linear factors.
Advanced (L2)	Factorize an expression using a combination of common factor and difference-of-squares identities.
Challenge (L3)	Factorize or simplify an expression using an introductory sum/difference of cubes identity.
Visual Priority	Low

Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Combined identity-based expansion and factorization, introductory cube identities
Question Bank Boundary — Should NOT Test	Full partial fraction decomposition (see O-Level)

2. Algebraic Fractions — Operations & Simplification

Topic Code	C10-AL-02
Domain	Algebra
Subtopics	Adding/subtracting with unlike denominators • Simplifying complex algebraic fractions • Solving equations involving algebraic fractions
Concept Description	Students add and subtract algebraic fractions with unlike denominators and solve equations involving them.
Learning Outcomes	Students can add or subtract algebraic fractions with unlike denominators and solve a resulting equation.
Skills Developed	Algebraic manipulation, Fraction operations, Equation solving
Prerequisites	Algebraic Fractions (Introductory) — Class 9.
Foundation (L1)	Add two algebraic fractions with unlike but simple denominators.
Advanced (L2)	Simplify a complex algebraic fraction involving factorization first.
Challenge (L3)	Solve an equation involving two or more algebraic fractions.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Operations on algebraic fractions with unlike denominators; simple equations involving them
Question Bank Boundary — Should NOT Test	Algebraic fractions requiring formal partial fraction decomposition

3. Simultaneous Equations — Linear & Quadratic

Topic Code	C10-AL-03
Domain	Algebra
Subtopics	One linear, one quadratic equation • Substitution method • Interpreting the number of solutions
Concept Description	Students solve simultaneous equations consisting of one linear and one quadratic equation, using substitution.
Learning Outcomes	Students can solve a simultaneous system of one linear and one quadratic equation and interpret the number of solutions.
Skills Developed	Algebraic manipulation, Substitution, Interpretation
Prerequisites	Simultaneous Linear Equations — Class 9; Quadratic Equations (both methods) — Class 9.
Foundation (L1)	Solve a simple linear-quadratic system by direct substitution.
Advanced (L2)	Solve a linear-quadratic system requiring rearrangement before substitution.

Challenge (L3)	Interpret geometrically (using a sketch) why a linear-quadratic system has zero, one, or two solutions.
Visual Priority	High
Recommended Question Types	Missing number, Graph-based MCQ
Question Bank Boundary — Should Test	Linear-quadratic simultaneous systems solved by substitution
Question Bank Boundary — Should NOT Test	Simultaneous equations involving two quadratics

4. Quadratic Equations — Discriminant & Nature of Roots

Topic Code	C10-AL-04
Domain	Algebra
Subtopics	The discriminant formula • Real, equal and complex-indicator cases • Using the discriminant to analyze a family of equations
Concept Description	Students calculate the discriminant of a quadratic equation and use it to determine the nature of its roots.
Learning Outcomes	Students can calculate the discriminant of a quadratic and state the nature of its roots.
Skills Developed	Formula application, Algebraic reasoning, Interpretation
Prerequisites	Quadratic Equations — Formula & Completing the Square — Class 9.
Foundation (L1)	Calculate the discriminant of a given quadratic equation.
Advanced (L2)	Use the discriminant to determine whether a quadratic has two, one, or no real roots.
Challenge (L3)	Find the range of values of a parameter for which a quadratic has real roots, using the discriminant.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Discriminant calculation and interpretation, including with an unknown parameter
Question Bank Boundary — Should NOT Test	Complex number roots (outside Class 9–10/O-Level scope)

5. Quadratic Inequalities

Topic Code	C10-AL-05
Domain	Algebra
Subtopics	Solving quadratic inequalities graphically • Solving algebraically using critical values • Representing solutions
Concept Description	Students solve quadratic inequalities using critical values and graphical reasoning, representing the solution set correctly.
Learning Outcomes	Students can solve a quadratic inequality and represent its solution set correctly.
Skills Developed	Algebraic manipulation, Graphical reasoning, Representation
Prerequisites	Quadratic Equations — Formula & Completing the Square — Class 9; Linear Inequalities — Class 9.

Foundation (L1)	Solve a quadratic inequality that factorizes directly, using a sketch of the parabola.
Advanced (L2)	Solve a quadratic inequality requiring the quadratic formula to find critical values first.
Challenge (L3)	Solve a real-life problem requiring the setup and solving of a quadratic inequality.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Quadratic inequalities solved via critical values and sketch reasoning
Question Bank Boundary — Should NOT Test	Inequalities involving rational or higher-degree polynomial expressions

6. Absolute Value Equations & Inequalities (Introductory)

Topic Code	C10-AL-06
Domain	Algebra
Subtopics	Meaning of absolute value • Solving simple absolute value equations • Solving simple absolute value inequalities
Concept Description	Students solve simple absolute value equations and inequalities, interpreting absolute value as distance from zero.
Learning Outcomes	Students can solve a simple absolute value equation or inequality and interpret it as a distance.
Skills Developed	Algebraic reasoning, Interpretation, Representation
Prerequisites	Linear Inequalities — Class 9.
Foundation (L1)	Solve a simple absolute value equation, e.g. $\|x - 2\| = 5$.
Advanced (L2)	Solve a simple absolute value inequality, e.g. $\|x + 1\| < 4$.
Challenge (L3)	Solve a real-life problem interpreting absolute value as a distance or tolerance constraint.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Simple absolute value equations/inequalities with a single absolute value term
Question Bank Boundary — Should NOT Test	Absolute value equations with absolute value terms on both sides

Domain: Exponentials & Logarithms

1. Exponential Equations

Topic Code	C10-EL-01
Domain	Exponentials & Logarithms
Subtopics	Solving by equating indices • Exponential equations requiring substitution • Real-life exponential equation applications
Concept Description	Students solve exponential equations by equating indices and by substitution, applying this to real-life contexts.

Learning Outcomes	Students can solve an exponential equation by equating indices or by an appropriate substitution.
Skills Developed	Index laws, Algebraic manipulation, Application
Prerequisites	Introduction to Exponential Expressions & Growth — Class 9.
Foundation (L1)	Solve an exponential equation where both sides can be written with the same base.
Advanced (L2)	Solve an exponential equation requiring a substitution (e.g. letting y = 2^x).
Challenge (L3)	Solve a real-life exponential growth/decay problem requiring the equation to be set up and solved.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Exponential equations solvable by equating indices or simple substitution
Question Bank Boundary — Should NOT Test	Exponential equations requiring logarithms with non-matching bases (see next topic)

2. Introduction to Logarithms & Laws of Logarithms

Topic Code	C10-EL-02
Domain	Exponentials & Logarithms
Subtopics	Logarithm as inverse of exponentiation • Laws of logarithms • Simple logarithmic equations
Concept Description	Students interpret logarithms as inverses of exponentiation and apply the laws of logarithms to simplify expressions.
Learning Outcomes	Students can convert between exponential and logarithmic form and apply a law of logarithms to simplify an expression.
Skills Developed	Logarithmic reasoning, Procedural fluency, Representation
Prerequisites	Exponential Equations (this track).
Foundation (L1)	Convert a simple exponential statement into logarithmic form and vice versa.
Advanced (L2)	Apply a single law of logarithms to simplify a logarithmic expression.
Challenge (L3)	Solve a simple logarithmic equation using the laws of logarithms.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Logarithmic notation, laws of logarithms, and simple logarithmic equations
Question Bank Boundary — Should NOT Test	Change of base formula (see O-Level)

Domain: Functions

1. Composite Functions

Topic Code	C10-FN-01
Domain	Functions

Subtopics	Composite function notation • Evaluating composite functions • Finding a composite function algebraically
Concept Description	Students evaluate and derive composite functions from two given functions.
Learning Outcomes	Students can evaluate a composite function for a given input and derive its algebraic expression.
Skills Developed	Function notation, Algebraic manipulation, Procedural fluency
Prerequisites	Function Notation, Domain & Range (Introductory) — Class 9.
Foundation (L1)	Evaluate fg(x) for a given numerical value of x.
Advanced (L2)	Find the algebraic expression for fg(x) given f(x) and g(x).
Challenge (L3)	Solve an equation involving a composite function, e.g. fg(x) = a given value.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Composite functions of linear and quadratic functions
Question Bank Boundary — Should NOT Test	Composite functions involving trigonometric or exponential functions (see later tracks)

2. Inverse Functions (Introductory)

Topic Code	C10-FN-02
Domain	Functions
Subtopics	Meaning of an inverse function • Finding an inverse function algebraically • Graphical relationship between a function and its inverse
Concept Description	Students find the inverse of a simple function algebraically and understand its graphical relationship to the original function.
Learning Outcomes	Students can find the inverse of a simple linear or simple function and describe its graphical relationship to the original.
Skills Developed	Algebraic manipulation, Function notation, Graphical reasoning
Prerequisites	Composite Functions (this track).
Foundation (L1)	Find the inverse of a simple linear function.
Advanced (L2)	Verify that two functions are inverses of each other using composition.
Challenge (L3)	Find the inverse of a function involving a simple square or square root, stating any domain restriction needed.
Visual Priority	High
Recommended Question Types	Standard MCQ, Graph-based MCQ
Question Bank Boundary — Should Test	Inverses of linear and simple non-linear functions
Question Bank Boundary — Should NOT Test	Inverses of trigonometric or exponential/logarithmic functions (see later tracks)

3. Graph Transformations — Translations & Reflections

Topic Code	C10-FN-03

Domain	Functions
Subtopics	f(x)+a and f(x+a) translations • Reflections −f(x) and f(−x) • Combining transformations
Concept Description	Students describe and sketch graph transformations involving translations and reflections of a given function.
Learning Outcomes	Students can sketch the graph of a simple transformation of a given function and describe the transformation in words.
Skills Developed	Graphical reasoning, Function notation, Communication
Prerequisites	Linear & Quadratic Functions — Graphs — Class 9.
Foundation (L1)	Sketch f(x) + a for a simple function f and constant a.
Advanced (L2)	Sketch f(x + a) or −f(x) for a simple function f.
Challenge (L3)	Describe, in function notation, the single or combined transformation that maps one given graph to another.
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Translations and reflections of linear and quadratic function graphs
Question Bank Boundary — Should NOT Test	Stretches/scalings of graphs (see O-Level/A-Level)

Domain: Equations & Inequalities

1. Rational Equations (Introductory)

Topic Code	C10-EQ-01
Domain	Equations & Inequalities
Subtopics	Equations with a variable in the denominator • Clearing denominators • Checking for extraneous solutions
Concept Description	Students solve simple rational equations by clearing denominators, checking for extraneous solutions.
Learning Outcomes	Students can solve a simple rational equation and check the solution for validity.
Skills Developed	Algebraic manipulation, Equation solving, Checking strategies
Prerequisites	Algebraic Fractions — Operations & Simplification (this track).
Foundation (L1)	Solve a rational equation with a single fraction term.
Advanced (L2)	Solve a rational equation with two fraction terms, clearing denominators.
Challenge (L3)	Solve a rational equation that produces an extraneous solution, and identify and reject it.
Visual Priority	Low
Recommended Question Types	Missing number, Standard MCQ
Question Bank Boundary — Should Test	Rational equations with linear denominators
Question Bank Boundary — Should NOT Test	Rational equations with quadratic denominators requiring factorization

2. Radical Equations (Introductory)

Topic Code	C10-EQ-02
Domain	Equations & Inequalities
Subtopics	Equations with a square root • Squaring both sides • Checking for extraneous solutions
Concept Description	Students solve simple radical (square root) equations by squaring both sides and checking for extraneous solutions.
Learning Outcomes	Students can solve a simple radical equation and verify the solution to reject any extraneous root.
Skills Developed	Algebraic manipulation, Equation solving, Checking strategies
Prerequisites	Real Number System & Surds (Introductory) — Class 9.
Foundation (L1)	Solve a radical equation with the square root isolated on one side.
Advanced (L2)	Solve a radical equation requiring rearrangement before squaring.
Challenge (L3)	Solve a radical equation that produces an extraneous solution, and identify and reject it by checking.
Visual Priority	Low
Recommended Question Types	Missing number, Standard MCQ
Question Bank Boundary — Should Test	Radical equations with one square root term
Question Bank Boundary — Should NOT Test	Radical equations with two square root terms

Domain: Sequences & Series

1. Arithmetic Series — Sum Formula

Topic Code	C10-SQ-01
Domain	Sequences & Series
Subtopics	Deriving the sum formula • Applying the sum formula • Word problems involving arithmetic series
Concept Description	Students derive and apply the sum formula for an arithmetic series, including in word problems.
Learning Outcomes	Students can apply the arithmetic series sum formula and solve a related word problem.
Skills Developed	Formula application, Algebraic reasoning, Problem solving
Prerequisites	Arithmetic Sequences — nth Term & Series — Class 9.
Foundation (L1)	Calculate the sum of the first n terms given the first term and common difference.
Advanced (L2)	Find the number of terms needed to reach a given sum.
Challenge (L3)	Solve a real-life word problem modelled by an arithmetic series (e.g. stacking, seating, savings).
Visual Priority	Low
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Sum formula for arithmetic series and its applications

Question Bank Boundary — Should NOT Test	Sigma notation (see O-Level)

2. Geometric Series — Sum Formula

Topic Code	C10-SQ-02
Domain	Sequences & Series
Subtopics	Sum of a finite geometric series • Sum to infinity (introductory, $\|r\|<1$) • Applications
Concept Description	Students calculate the sum of a finite geometric series and, where the ratio's magnitude is less than 1, the sum to infinity.
Learning Outcomes	Students can calculate the sum of a finite geometric series and, where applicable, the sum to infinity.
Skills Developed	Formula application, Algebraic reasoning, Application
Prerequisites	Geometric Sequences (Introductory) — Class 9.
Foundation (L1)	Calculate the sum of the first n terms of a geometric series.
Advanced (L2)	Calculate the sum to infinity of a geometric series with $\|r\| < 1$.
Challenge (L3)	Solve a real-life problem modelled by a geometric series (e.g. compound scenarios, repeated halving).
Visual Priority	Low
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Finite geometric series sum; introductory sum to infinity
Question Bank Boundary — Should NOT Test	Formal proof of convergence (see A-Level)

3. Sequence & Series Applications

Topic Code	C10-SQ-03
Domain	Sequences & Series
Subtopics	Modelling real-life situations with sequences • Mixed arithmetic/geometric problems • Multi-step sequence reasoning
Concept Description	Students apply arithmetic and geometric sequence/series concepts to model and solve real-life multi-step problems.
Learning Outcomes	Students can model a real-life situation using a sequence or series and solve a related multi-step problem.
Skills Developed	Mathematical modelling, Problem solving, Application
Prerequisites	Arithmetic Series — Sum Formula, Geometric Series — Sum Formula (this track).
Foundation (L1)	Identify whether a real-life scenario is best modelled by an arithmetic or geometric sequence.
Advanced (L2)	Solve a two-step problem combining sequence identification with a sum calculation.
Challenge (L3)	Solve an unfamiliar multi-step problem combining both arithmetic and geometric reasoning.
Visual Priority	Medium
Recommended Question Types	Word problem, Multi-step problem

Question Bank Boundary — Should Test	Sequence/series modelling using Class 10 arithmetic and geometric concepts
Question Bank Boundary — Should NOT Test	Recursive sequences beyond simple arithmetic/geometric cases (see A-Level)

Domain: Euclidean Geometry

1. Circle Geometry — Cyclic Quadrilaterals

Topic Code	C10-GE-01
Domain	Euclidean Geometry
Subtopics	Opposite angles of a cyclic quadrilateral • Exterior angle property • Applications in multi-step diagrams
Concept Description	Students apply the properties of cyclic quadrilaterals to find missing angles in circle diagrams.
Learning Outcomes	Students can use the cyclic quadrilateral angle properties to find a missing angle.
Skills Developed	Geometric reasoning, Circle properties, Application
Prerequisites	Circle Geometry — Chords & Arcs — Class 9.
Foundation (L1)	Find a missing angle using the opposite-angles-sum-to-180° property.
Advanced (L2)	Find a missing angle using the exterior angle property of a cyclic quadrilateral.
Challenge (L3)	Solve a multi-step diagram combining cyclic quadrilateral properties with other circle facts.
Visual Priority	High
Recommended Question Types	Geometry MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Cyclic quadrilateral angle properties
Question Bank Boundary — Should NOT Test	Formal proof of the cyclic quadrilateral theorem

2. Circle Geometry — Tangent-Chord Angle

Topic Code	C10-GE-02
Domain	Euclidean Geometry
Subtopics	The tangent-chord (alternate segment) angle property • Applications • Multi-step tangent-chord problems
Concept Description	Students apply the tangent-chord angle property to find missing angles involving a tangent and a chord.
Learning Outcomes	Students can use the tangent-chord angle property to find a missing angle in a circle diagram.
Skills Developed	Geometric reasoning, Circle properties, Application
Prerequisites	Circle Geometry — Tangents (Introductory) — Class 9.
Foundation (L1)	Identify the angle described by the tangent-chord property in a labelled diagram.
Advanced (L2)	Find a missing angle using the tangent-chord angle property directly.
Challenge (L3)	Solve a multi-step diagram combining the tangent-chord property with cyclic quadrilateral or other circle facts.
Visual Priority	High

Recommended Question Types	Geometry MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Tangent-chord (alternate segment) angle property
Question Bank Boundary — Should NOT Test	Formal proof of the tangent-chord theorem

3. Advanced Similarity & Area Ratios

Topic Code	C10-GE-03
Domain	Euclidean Geometry
Subtopics	Similar triangles within circles/polygons • Area ratios from similarity • Multi-step similarity problems
Concept Description	Students apply similarity in more advanced contexts, including finding area ratios and solving multi-step problems.
Learning Outcomes	Students can identify similar triangles in an advanced context and find an area ratio using the scale factor.
Skills Developed	Geometric reasoning, Proportional reasoning, Application
Prerequisites	Congruence & Similarity — Advanced Reasoning — Class 9.
Foundation (L1)	Find the scale factor between two similar triangles in a moderately complex figure.
Advanced (L2)	Find the area ratio between two similar triangles given their scale factor.
Challenge (L3)	Solve a multi-step problem requiring similarity reasoning combined with area or length calculation.
Visual Priority	High
Recommended Question Types	Geometry MCQ, Standard MCQ
Question Bank Boundary — Should Test	Similarity and area ratio problems in moderately complex figures
Question Bank Boundary — Should NOT Test	Similarity problems requiring trigonometric ratios

4. Multi-Step Geometric Proof

Topic Code	C10-GE-04
Domain	Euclidean Geometry
Subtopics	Combining circle, triangle and polygon facts • Structuring a complete proof • Communicating each justified step
Concept Description	Students construct complete, multi-step geometric proofs combining circle, triangle and polygon properties.
Learning Outcomes	Students can construct and communicate a complete multi-step proof combining several geometric properties.
Skills Developed	Geometric reasoning, Proof construction, Communication
Prerequisites	Geometric Proof — Multi-Step Reasoning — Class 9.
Foundation (L1)	Complete a partially-given multi-step proof involving circle or triangle facts.
Advanced (L2)	Construct a proof combining two different types of geometric fact (e.g. circle and triangle).

Challenge (L3)	Construct an original multi-step proof for an unfamiliar diagram, combining three or more properties.
Visual Priority	High
Recommended Question Types	Proof/reasoning question, Geometry MCQ
Question Bank Boundary — Should Test	Multi-step justified proofs using Class 10 geometry facts
Question Bank Boundary — Should NOT Test	Formal two-column or axiomatic proof format (see O-Level)

5. Constructions & Loci (Introductory)

Topic Code	C10-GE-05
Domain	Euclidean Geometry
Subtopics	Standard ruler-and-compass constructions • Loci definitions • Combining constructions with loci
Concept Description	Students perform standard geometric constructions and describe and construct simple loci.
Learning Outcomes	Students can perform a standard construction and describe the locus of points satisfying a given condition.
Skills Developed	Spatial reasoning, Precision, Communication
Prerequisites	Pioneer Level geometric reasoning.
Foundation (L1)	Construct the perpendicular bisector of a line segment.
Advanced (L2)	Describe the locus of points equidistant from two given points or lines.
Challenge (L3)	Construct a locus satisfying two combined conditions (e.g. equidistant from a point and a line).
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Standard constructions and simple loci descriptions
Question Bank Boundary — Should NOT Test	Loci requiring coordinate geometry equations (see Coordinate Geometry topics)

Domain: Coordinate Geometry

1. Equation of a Circle (Introductory)

Topic Code	C10-CG-01
Domain	Coordinate Geometry
Subtopics	Standard form $(x-a)^2+(y-b)^2=r^2$ • Finding centre and radius • Determining if a point lies on a circle
Concept Description	Students interpret and use the standard equation of a circle to find its centre and radius and test points.
Learning Outcomes	Students can find the centre and radius of a circle from its equation and determine whether a point lies on it.
Skills Developed	Coordinate reasoning, Algebraic manipulation, Application

Prerequisites	Distance, Midpoint & Gradient — Class 9.
Foundation (L1)	State the centre and radius of a circle given in standard form.
Advanced (L2)	Determine whether a given point lies on, inside, or outside a circle.
Challenge (L3)	Find the equation of a circle given its centre and a point on its circumference.
Visual Priority	High
Recommended Question Types	Standard MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Standard form equation of a circle; centre, radius, and point-testing
Question Bank Boundary — Should NOT Test	Tangent lines to a circle (see O-Level)

2. Coordinate Geometry Proofs

Topic Code	C10-CG-02
Domain	Coordinate Geometry
Subtopics	Proving shape properties using coordinates • Using distance, midpoint and gradient together • Structuring a coordinate proof
Concept Description	Students use distance, midpoint and gradient formulas together to prove properties of shapes on the coordinate plane.
Learning Outcomes	Students can construct a coordinate proof of a simple shape property (e.g. a triangle is isosceles).
Skills Developed	Coordinate reasoning, Proof construction, Communication
Prerequisites	Parallel & Perpendicular Lines — Class 9.
Foundation (L1)	Use the distance formula to show that two given sides of a triangle are equal.
Advanced (L2)	Use gradient to show that a triangle is right-angled.
Challenge (L3)	Construct a complete coordinate proof combining distance, midpoint and gradient reasoning for an unfamiliar shape.
Visual Priority	High
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Coordinate proofs using distance, midpoint and gradient formulas together
Question Bank Boundary — Should NOT Test	Coordinate proofs requiring circle equations (see separate topic)

3. Geometric Loci on the Coordinate Plane

Topic Code	C10-CG-03
Domain	Coordinate Geometry
Subtopics	Loci as equations • Equidistant loci • Combining loci with other coordinate geometry
Concept Description	Students express geometric loci as coordinate equations and solve problems combining loci with other coordinate skills.

Learning Outcomes	Students can find the equation of a simple locus described geometrically on the coordinate plane.
Skills Developed	Coordinate reasoning, Algebraic manipulation, Application
Prerequisites	Constructions & Loci (Introductory) — this track; Equation of a Circle (Introductory) — this track.
Foundation (L1)	Find the equation of the locus of points equidistant from two given points (the perpendicular bisector).
Advanced (L2)	Find the equation of the locus of points a fixed distance from a given point (a circle).
Challenge (L3)	Solve a multi-step problem finding the intersection of two loci.
Visual Priority	High
Recommended Question Types	Standard MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Loci expressible as straight lines or circles on the coordinate plane
Question Bank Boundary — Should NOT Test	Loci requiring parametric or vector equations (see A-Level)

Domain: Mensuration

1. Composite Solids — Advanced Problems

Topic Code	C10-MN-01
Domain	Mensuration
Subtopics	Composite solids combining curved and rectilinear parts • Missing-dimension problems • Real-life composite solid contexts
Concept Description	Students calculate the surface area or volume of composite solids combining curved and rectilinear parts.
Learning Outcomes	Students can calculate the surface area or volume of a composite solid combining curved and flat-faced parts.
Skills Developed	Spatial reasoning, Formula application, Multi-step calculation
Prerequisites	Surface Area & Volume of Cylinders, Cones & Spheres — Class 9.
Foundation (L1)	Calculate the volume of a composite solid formed from a cylinder and a cone.
Advanced (L2)	Calculate the surface area of a composite solid, being careful to exclude internal joined faces.
Challenge (L3)	Find a missing dimension of a composite solid given its total volume or surface area.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Word problem
Question Bank Boundary — Should Test	Composite solids combining prisms, cylinders, cones and/or spheres
Question Bank Boundary — Should NOT Test	Composite solids requiring calculus-based volume derivation

2. Arc Length & Sector Area

Topic Code	C10-MN-02

Domain	Mensuration
Subtopics	Arc length formula • Sector area formula • Composite problems with sectors
Concept Description	Students calculate arc length and sector area using the appropriate fraction of the circle's circumference or area.
Learning Outcomes	Students can calculate the arc length or area of a sector given the radius and angle.
Skills Developed	Formula application, Proportional reasoning, Spatial reasoning
Prerequisites	Introduction to Circles — Pioneer Level.
Foundation (L1)	Calculate the arc length of a sector given its angle and the circle's radius.
Advanced (L2)	Calculate the area of a sector given its angle and the circle's radius.
Challenge (L3)	Solve a composite problem combining sector area or arc length with another shape.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Word problem
Question Bank Boundary — Should Test	Arc length and sector area for any given angle
Question Bank Boundary — Should NOT Test	Radian measure (see A-Level)

Domain: Trigonometry

1. Sine Rule

Topic Code	C10-TR-01
Domain	Trigonometry
Subtopics	The sine rule formula • Finding a missing side • Finding a missing angle, including the ambiguous case
Concept Description	Students apply the sine rule to find missing sides and angles in non-right triangles, including the ambiguous case.
Learning Outcomes	Students can apply the sine rule to find a missing side or angle in a non-right triangle.
Skills Developed	Trigonometric reasoning, Formula application, Problem solving
Prerequisites	Right-Triangle Trigonometry — Sine, Cosine, Tangent — Class 9.
Foundation (L1)	Find a missing side using the sine rule given two angles and one side.
Advanced (L2)	Find a missing angle using the sine rule given two sides and one angle.
Challenge (L3)	Recognise and resolve the ambiguous case of the sine rule, finding both possible solutions.
Visual Priority	High
Recommended Question Types	Geometry MCQ, Standard MCQ
Question Bank Boundary — Should Test	Sine rule for finding sides and angles, including the ambiguous case
Question Bank Boundary — Should NOT Test	Trigonometric identities beyond the sine rule (see O-Level)

2. Cosine Rule

Topic Code	C10-TR-02
Domain	Trigonometry
Subtopics	The cosine rule formula • Finding a missing side • Finding a missing angle
Concept Description	Students apply the cosine rule to find missing sides and angles in non-right triangles.
Learning Outcomes	Students can apply the cosine rule to find a missing side or angle in a non-right triangle.
Skills Developed	Trigonometric reasoning, Formula application, Problem solving
Prerequisites	Sine Rule (this track).
Foundation (L1)	Find a missing side using the cosine rule given two sides and the included angle.
Advanced (L2)	Find a missing angle using the cosine rule given three sides.
Challenge (L3)	Solve a multi-step problem requiring the student to choose between the sine and cosine rule.
Visual Priority	High
Recommended Question Types	Geometry MCQ, Standard MCQ
Question Bank Boundary — Should Test	Cosine rule for finding sides and angles; choosing between sine/cosine rule
Question Bank Boundary — Should NOT Test	Trigonometric identities beyond the cosine rule (see O-Level)

3. Area of a Triangle Using Trigonometry

Topic Code	C10-TR-03
Domain	Trigonometry
Subtopics	The (1/2)ab sin C formula • Applications • Combining with sine/cosine rule
Concept Description	Students calculate the area of a triangle using the trigonometric area formula and combine this with the sine/cosine rules.
Learning Outcomes	Students can calculate the area of a triangle using two sides and the included angle.
Skills Developed	Formula application, Trigonometric reasoning, Problem solving
Prerequisites	Cosine Rule (this track).
Foundation (L1)	Calculate the area of a triangle given two sides and the included angle.
Advanced (L2)	Find a missing angle or side given the area of a triangle and other information.
Challenge (L3)	Solve a multi-step problem combining the area formula with the sine or cosine rule.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Trigonometric area formula and its combination with sine/cosine rules
Question Bank Boundary — Should NOT Test	Heron's formula (outside this level's syllabus)

4. Trigonometric Graphs (Introductory)

Topic Code	C10-TR-04
Domain	Trigonometry

Subtopics	Graphs of sine and cosine (0°–360°) • Key features (amplitude, period) • Reading values from the graph
Concept Description	Students sketch and interpret the graphs of sine and cosine functions over 0° to 360°, identifying key features.
Learning Outcomes	Students can sketch the graph of sine or cosine over 0°–360° and identify its amplitude and period.
Skills Developed	Graphing, Pattern recognition, Interpretation
Prerequisites	Sine Rule, Cosine Rule (this track).
Foundation (L1)	Identify the amplitude and period of a basic sine or cosine graph.
Advanced (L2)	Sketch the graph of sine or cosine over the full 0°–360° range, labelling key points.
Challenge (L3)	Read multiple solutions from a trigonometric graph for a given equation (e.g. sin x = 0.5).
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Graphs of sine and cosine over 0°–360°
Question Bank Boundary — Should NOT Test	Graph transformations of trigonometric functions (see A-Level)

Domain: Statistics

1. Cumulative Frequency Curves & Median Estimation

Topic Code	C10-ST-01
Domain	Statistics
Subtopics	Plotting a cumulative frequency curve • Estimating median and quartiles from the curve • Interquartile range from the curve
Concept Description	Students plot cumulative frequency curves and use them to estimate the median, quartiles and interquartile range.
Learning Outcomes	Students can plot a cumulative frequency curve and use it to estimate the median and interquartile range.
Skills Developed	Data representation, Estimation, Interpretation
Prerequisites	Cumulative Frequency & Quartiles — Class 9.
Foundation (L1)	Plot a cumulative frequency curve from a given table.
Advanced (L2)	Use a cumulative frequency curve to estimate the median.
Challenge (L3)	Use a cumulative frequency curve to estimate the interquartile range and compare two data sets.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Data interpretation
Question Bank Boundary — Should Test	Cumulative frequency curves and estimation of median/IQR from them
Question Bank Boundary — Should NOT Test	Box plots (see O-Level)

2. Variance & Standard Deviation (Introductory)

Topic Code	C10-ST-02
Domain	Statistics
Subtopics	Meaning of variance and standard deviation • Calculating from a small data set • Interpreting spread
Concept Description	Students calculate the variance and standard deviation of a small data set and interpret them as measures of spread.
Learning Outcomes	Students can calculate the standard deviation of a small data set and interpret its meaning.
Skills Developed	Data analysis, Formula application, Interpretation
Prerequisites	Mean, Median & Mode for Grouped Data — Class 9.
Foundation (L1)	Calculate the mean and deviations from the mean for a small data set.
Advanced (L2)	Calculate the variance and standard deviation of a small ungrouped data set.
Challenge (L3)	Compare the standard deviations of two data sets and interpret what this reveals about their spread.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Data interpretation
Question Bank Boundary — Should Test	Variance and standard deviation for small ungrouped data sets
Question Bank Boundary — Should NOT Test	Standard deviation of grouped/continuous data (see O-Level/A-Level)

3. Comparing Distributions

Topic Code	C10-ST-03
Domain	Statistics
Subtopics	Comparing measures of centre and spread • Interpreting differences between distributions • Justified conclusions
Concept Description	Students compare two or more distributions using measures of centre and spread and justify conclusions.
Learning Outcomes	Students can compare two distributions using appropriate measures and justify a conclusion.
Skills Developed	Data analysis, Comparison, Communication
Prerequisites	Variance & Standard Deviation (Introductory) — this track.
Foundation (L1)	Compare two distributions using their means.
Advanced (L2)	Compare two distributions using both a measure of centre and a measure of spread.
Challenge (L3)	Justify a conclusion about two distributions using cumulative frequency, standard deviation and context together.
Visual Priority	Medium
Recommended Question Types	Data interpretation, Standard MCQ
Question Bank Boundary — Should Test	Comparison using mean/median and range/standard deviation together
Question Bank Boundary — Should NOT Test	Formal statistical hypothesis testing

Domain: Probability

1. Conditional Probability (Introductory)

Topic Code	C10-PR-01
Domain	Probability
Subtopics	Meaning of conditional probability • Calculating P(A|B) from a table or tree diagram • Real-life conditional probability contexts
Concept Description	Students calculate conditional probability from tables, tree diagrams and real-life contexts.
Learning Outcomes	Students can calculate a conditional probability from a two-way table or tree diagram.
Skills Developed	Probability reasoning, Data interpretation, Application
Prerequisites	Tree Diagrams & Combined Events — Class 9.
Foundation (L1)	Calculate a conditional probability directly from a two-way table.
Advanced (L2)	Calculate a conditional probability from a tree diagram involving dependent events.
Challenge (L3)	Solve a real-life problem requiring conditional probability reasoning across multiple stages.
Visual Priority	High
Recommended Question Types	Data interpretation, Standard MCQ
Question Bank Boundary — Should Test	Conditional probability from tables and tree diagrams
Question Bank Boundary — Should NOT Test	Formal Bayes' theorem (see O-Level/A-Level)

2. Venn Diagrams & Set-Based Probability

Topic Code	C10-PR-02
Domain	Probability
Subtopics	Constructing Venn diagrams • Set notation for probability • Calculating probabilities from Venn diagrams
Concept Description	Students construct Venn diagrams and use set notation to calculate probabilities of combined events.
Learning Outcomes	Students can construct a Venn diagram from given information and use it to calculate a probability.
Skills Developed	Set reasoning, Probability reasoning, Representation
Prerequisites	Mutually Exclusive & Independent Events — Class 9.
Foundation (L1)	Complete a two-set Venn diagram from given frequency information.
Advanced (L2)	Use set notation (union, intersection, complement) to describe and calculate a probability.
Challenge (L3)	Construct and use a three-set Venn diagram to solve a multi-step probability problem.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Two- and three-set Venn diagrams with basic set notation

Question Bank Boundary — Should NOT Test	Formal set algebra beyond union/intersection/complement

Domain: Combinatorics & Counting

1. Permutations (Introductory)

Topic Code	C10-CO-01
Domain	Combinatorics & Counting
Subtopics	Meaning of a permutation • Factorial notation • Calculating permutations of n distinct items
Concept Description	Students use factorial notation to calculate the number of permutations (arrangements) of distinct items.
Learning Outcomes	Students can calculate the number of permutations of n distinct items, or of r items chosen from n.
Skills Developed	Combinatorial reasoning, Formula application, Systematic counting
Prerequisites	Fundamental Counting Principle & Organized Counting — Class 9.
Foundation (L1)	Calculate the number of ways to arrange all of a small set of distinct items.
Advanced (L2)	Calculate the number of permutations of r items chosen from n distinct items.
Challenge (L3)	Solve a permutation problem with a simple restriction (e.g. two specific items must be together).
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Logical reasoning
Question Bank Boundary — Should Test	Permutations of distinct items, with and without simple restrictions
Question Bank Boundary — Should NOT Test	Permutations with repeated items (see O-Level)

2. Combinations (Introductory)

Topic Code	C10-CO-02
Domain	Combinatorics & Counting
Subtopics	Meaning of a combination • Combination formula (nCr) • Distinguishing permutations from combinations
Concept Description	Students use the combination formula to calculate the number of ways to select items when order does not matter.
Learning Outcomes	Students can calculate the number of combinations of r items chosen from n and distinguish this from a permutation problem.
Skills Developed	Combinatorial reasoning, Formula application, Classification
Prerequisites	Permutations (Introductory) (this track).
Foundation (L1)	Calculate the number of ways to choose r items from n where order does not matter.
Advanced (L2)	Determine whether a given problem requires permutations or combinations, and solve accordingly.
Challenge (L3)	Solve a combination problem with a simple restriction (e.g. a specific item must/must not be selected).

Visual Priority	Medium
Recommended Question Types	Standard MCQ, Logical reasoning
Question Bank Boundary — Should Test	Combinations of distinct items, with and without simple restrictions
Question Bank Boundary — Should NOT Test	Combinations with repetition allowed

Domain: Vectors

1. Vector Notation, Magnitude & Direction

Topic Code	C10-VE-01
Domain	Vectors
Subtopics	Vector notation (column and component form) • Calculating magnitude • Direction of a vector
Concept Description	Students represent vectors in column and component form and calculate their magnitude.
Learning Outcomes	Students can represent a vector in column form and calculate its magnitude.
Skills Developed	Vector reasoning, Formula application, Spatial reasoning
Prerequisites	Coordinate plane concepts (Pioneer Level).
Foundation (L1)	Write a vector connecting two given points in column form.
Advanced (L2)	Calculate the magnitude of a given vector.
Challenge (L3)	Find a vector of a given magnitude in the same direction as a given vector.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Column vector notation and magnitude calculation
Question Bank Boundary — Should NOT Test	Three-dimensional vectors (see A-Level)

2. Vector Addition & Position Vectors

Topic Code	C10-VE-02
Domain	Vectors
Subtopics	Adding and subtracting vectors • Scalar multiplication • Position vectors
Concept Description	Students add, subtract and scale vectors, and use position vectors to represent points relative to an origin.
Learning Outcomes	Students can add, subtract or scale vectors and use position vectors to find a vector between two points.
Skills Developed	Vector reasoning, Algebraic manipulation, Spatial reasoning
Prerequisites	Vector Notation, Magnitude & Direction (this track).
Foundation (L1)	Add or subtract two given vectors.
Advanced (L2)	Find the vector between two points given their position vectors.

Challenge (L3)	Solve a simple geometric problem using vector addition and position vectors (e.g. finding a midpoint vector).
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Vector addition, subtraction, scalar multiplication and position vectors
Question Bank Boundary — Should NOT Test	Vector proofs of collinearity or ratio division (see O-Level)

Domain: Mathematical Logic, Proof & Reasoning

1. Direct & Indirect Reasoning

Topic Code	C10-LR-01
Domain	Mathematical Logic, Proof & Reasoning
Subtopics	Direct proof structure • Introductory indirect reasoning (proof sketch) • Choosing an appropriate reasoning approach
Concept Description	Students construct direct proofs and are introduced to the structure of indirect (contradiction-style) reasoning.
Learning Outcomes	Students can construct a direct proof and describe, in outline, how an indirect argument would proceed.
Skills Developed	Logical reasoning, Proof construction, Communication
Prerequisites	Algebraic & Geometric Proof (Introductory) — Class 9.
Foundation (L1)	Construct a direct proof of a simple algebraic claim.
Advanced (L2)	Describe, in outline, why assuming the opposite of a claim leads to a contradiction (without full formal rigor).
Challenge (L3)	Choose between a direct and an indirect approach for a given claim and justify the choice.
Visual Priority	Low
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Direct proof; introductory outline-level indirect reasoning
Question Bank Boundary — Should NOT Test	Formal proof by contradiction with full rigor (see A-Level)

2. Divisibility & Algebraic Proof

Topic Code	C10-LR-02
Domain	Mathematical Logic, Proof & Reasoning
Subtopics	Algebraic representation of divisibility claims • Proving a divisibility claim • Multi-step number theory proofs
Concept Description	Students use algebraic representation to prove divisibility claims about integers.
Learning Outcomes	Students can construct an algebraic proof of a divisibility claim (e.g. that an expression is always divisible by a given number).

Skills Developed	Algebraic reasoning, Proof construction, Number theory
Prerequisites	Direct & Indirect Reasoning (this track).
Foundation (L1)	Represent a class of integers algebraically (e.g. multiples of 3 as 3n).
Advanced (L2)	Prove that a simple algebraic expression is always divisible by a given number.
Challenge (L3)	Prove a multi-step divisibility claim combining more than one algebraic representation.
Visual Priority	Low
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Algebraic proofs of divisibility claims using Class 10 algebra
Question Bank Boundary — Should NOT Test	Formal modular arithmetic notation

Domain: Problem Solving & Mathematical Modelling

1. Multi-Step Analytical Problem Solving

Topic Code	C10-PS-01
Domain	Problem Solving & Mathematical Modelling
Subtopics	Problems combining several Class 10 domains • Analytical planning strategies • Self-checking multi-step solutions
Concept Description	Students solve multi-step analytical problems combining several Class 10 domains, planning and checking their approach.
Learning Outcomes	Students can plan, solve and check a multi-step analytical problem combining several Class 10 domains.
Skills Developed	Problem solving, Analytical thinking, Self-checking
Prerequisites	Broad Class 10 topic base.
Foundation (L1)	Solve a two-domain analytical problem with familiar numbers.
Advanced (L2)	Solve a three-step analytical problem combining two or three domains.
Challenge (L3)	Solve an unfamiliar analytical problem combining three or more Class 10 domains.
Visual Priority	Medium
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Multi-step, multi-domain analytical problems built from Class 10 concepts
Question Bank Boundary — Should NOT Test	Problems requiring concepts beyond Class 10 scope

2. Mathematical Modelling — Growth & Rates

Topic Code	C10-PS-02
Domain	Problem Solving & Mathematical Modelling
Subtopics	Modelling growth/decay situations • Modelling rate-based situations • Evaluating model assumptions

Concept Description	Students build and evaluate mathematical models of growth, decay and rate-based real-life situations.
Learning Outcomes	Students can build a model of a growth, decay or rate-based situation and evaluate its assumptions.
Skills Developed	Mathematical modelling, Critical thinking, Communication
Prerequisites	Broad Class 10 topic base including sequences and exponentials.
Foundation (L1)	Identify whether a described situation is best modelled linearly, exponentially, or otherwise.
Advanced (L2)	Build an equation or sequence modelling a described growth or rate situation.
Challenge (L3)	Evaluate the assumptions and limitations of a given growth/rate model and suggest a refinement.
Visual Priority	Medium
Recommended Question Types	Word problem, Standard MCQ
Question Bank Boundary — Should Test	Modelling using Class 10 sequences, exponentials and algebra
Question Bank Boundary — Should NOT Test	Modelling requiring calculus (see A-Level)

Markhor Junior Mathematics — Aspirant Level — O-Level

Course Overview

Markhor Junior Mathematics — Aspirant Level — O-Level delivers internationally-benchmarked secondary mathematics with advanced algebra, geometry, statistics and probability. Students work with sets, advanced factorization (including sum/difference of cubes and partial fractions), polynomial division, the remainder and factor theorems, the complete set of circle theorems, three-dimensional geometry, advanced coordinate geometry (including tangents to circles), trigonometric identities and equations, standard deviation, correlation and regression, formal conditional probability, advanced permutations and combinations, vector proofs, and an introduction to formal mathematical proof by contradiction. Advanced multi-step problem solving and introductory optimization modelling complete this internationally rigorous track.

Mathematical Domains & Topics

Number Systems & Number Theory

- Sets — Notation & Venn Diagram Operations
- Surds & Indices — Advanced Manipulation
- Number Theory — Modular Reasoning (Introductory)

Algebra

- Advanced Factorization — Sum/Difference of Cubes
- Partial Fractions (Introductory)
- Polynomial Division
- Remainder & Factor Theorem
- Quadratic Functions — Completing the Square & Vertex Form
- Simultaneous Equations — Three Variables (Introductory)

Exponentials & Logarithms

- Laws of Logarithms — Advanced Applications
- Exponential & Logarithmic Equations — Combined

Functions

- Domain & Range — Advanced Reasoning
- Composite & Inverse Functions — Advanced
- Polynomial Functions — Graphs & Behaviour
- Rational Functions (Introductory)

Equations & Inequalities

- Polynomial Equations — Higher Degree
- Simultaneous Equations — Graphical & Algebraic Methods
- Inequalities — Graphical Regions

Sequences & Series

- Sigma Notation (Introductory)
- Sequences & Series — Combined Applications

Euclidean Geometry

- Circle Theorems — Comprehensive Application
- Congruence & Similarity — Formal Proof
- Geometric Proof — Multi-Theorem Problems
- Constructions & Loci — Advanced

- Three-Dimensional Geometry (Introductory)

Coordinate Geometry

- Equation of a Circle — Advanced
- Tangent to a Circle — Coordinate Methods
- Perpendicular Bisector & Loci
- Coordinate Geometry — Multi-Step Proof

Mensuration

- Surface Area & Volume — Advanced Composite Solids
- Mensuration in 3D Coordinate Contexts

Trigonometry

- Trigonometric Identities (Introductory)
- Trigonometric Equations (Introductory)
- Graphs of Sine, Cosine & Tangent
- Bearings & 3D Trigonometry
- Sine/Cosine Rule — Advanced Applications

Statistics

- Standard Deviation — Advanced Calculation
- Correlation & Scatter Diagrams
- Regression Concepts (Introductory)
- Comparing & Interpreting Complex Data Sets

Probability

- Conditional Probability — Formal Treatment
- Independent & Dependent Events — Advanced
- Expected Value (Introductory)

Combinatorics & Counting

- Permutations — Advanced (with Restrictions)
- Combinations — Advanced (with Restrictions)
- Combinatorial Problem Solving

Vectors

- Vector Geometry — Ratio of Line Segments
- Vector Proofs — Collinearity & Parallelism

Mathematical Logic, Proof & Reasoning

- Formal Mathematical Proof — Direct & by Contradiction (Introductory)
- Advanced Logical & Algebraic Reasoning

Problem Solving & Mathematical Modelling

- Advanced Multi-Step Problem Solving
- Mathematical Modelling — Optimization (Introductory)

Detailed Topic-by-Topic Curriculum — O-Level

Domain: Number Systems & Number Theory

1. Sets — Notation & Venn Diagram Operations

Topic Code	OL-NT-01
Domain	Number Systems & Number Theory
Subtopics	Set notation • Union, intersection, complement • Venn diagrams for up to three sets
Concept Description	Students use formal set notation and Venn diagrams to represent and solve problems involving unions, intersections and complements.
Learning Outcomes	Students can use set notation correctly and solve a problem using a two- or three-set Venn diagram.
Skills Developed	Set reasoning, Representation, Application
Prerequisites	Venn Diagrams & Set-Based Probability — Class 10.
Foundation (L1)	Use set notation to describe the union or intersection of two sets.
Advanced (L2)	Solve a problem using a two-set Venn diagram with numerical values.
Challenge (L3)	Solve a multi-step problem using a three-set Venn diagram.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Formal set notation and Venn diagrams for up to three sets
Question Bank Boundary — Should NOT Test	Formal proofs of set identities (e.g. De Morgan's laws)

2. Surds & Indices — Advanced Manipulation

Topic Code	OL-NT-02
Domain	Number Systems & Number Theory
Subtopics	Advanced surd simplification • Solving surd equations • Combined index and surd expressions
Concept Description	Students perform advanced manipulation of surds and indices, including solving equations involving surds.
Learning Outcomes	Students can simplify a combined surd/index expression and solve a simple equation involving surds.
Skills Developed	Algebraic manipulation, Procedural fluency, Equation solving
Prerequisites	Surds — Simplification & Rationalizing; Indices — Fractional & Negative Indices — Class 10.
Foundation (L1)	Simplify an expression combining surds and fractional indices.
Advanced (L2)	Solve an equation of the form $\sqrt{(x+a)} = b$.
Challenge (L3)	Solve an equation involving two surd terms, checking for extraneous solutions.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number

Question Bank Boundary — Should Test	Advanced surd/index manipulation and equations with one or two surd terms
Question Bank Boundary — Should NOT Test	Equations requiring complex number reasoning

3. Number Theory — Modular Reasoning (Introductory)

Topic Code	OL-NT-03
Domain	Number Systems & Number Theory
Subtopics	Remainders on division • Simple modular patterns • Applications to divisibility and puzzles
Concept Description	Students reason about remainders and simple modular patterns to solve number theory puzzles.
Learning Outcomes	Students can use remainder/modular reasoning to solve a number theory puzzle or divisibility problem.
Skills Developed	Number theory, Pattern recognition, Logical reasoning
Prerequisites	Number Theory — Diophantine-Style Problems — Class 10.
Foundation (L1)	Find the remainder when a number is divided by a given divisor.
Advanced (L2)	Use a repeating remainder pattern to find a remainder for a large exponent or term number.
Challenge (L3)	Solve a competition-style puzzle requiring combined modular and divisibility reasoning.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Logical reasoning
Question Bank Boundary — Should Test	Informal remainder/modular reasoning without formal notation
Question Bank Boundary — Should NOT Test	Formal modular arithmetic notation (mod n) or number theory theorems

Domain: Algebra

1. Advanced Factorization — Sum/Difference of Cubes

Topic Code	OL-AL-01
Domain	Algebra
Subtopics	Sum of two cubes identity • Difference of two cubes identity • Applications to simplification
Concept Description	Students apply the sum and difference of cubes identities to factorize and simplify expressions.
Learning Outcomes	Students can factorize an expression using the sum or difference of cubes identity.
Skills Developed	Algebraic manipulation, Pattern recognition, Procedural fluency
Prerequisites	Algebraic Identities — Advanced Expansion/Factorization — Class 10.
Foundation (L1)	Recognise a sum or difference of two cubes in an expression.
Advanced (L2)	Factorize an expression using the sum or difference of cubes identity.
Challenge (L3)	Simplify a more complex expression requiring cube identities combined with other factorization techniques.
Visual Priority	Low

Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Sum and difference of cubes identities and their applications
Question Bank Boundary — Should NOT Test	Factorization of higher-degree polynomials beyond cubic identities

2. Partial Fractions (Introductory)

Topic Code	OL-AL-02
Domain	Algebra
Subtopics	Decomposing simple rational expressions • Distinct linear factors • Checking by recombining
Concept Description	Students decompose simple rational expressions with distinct linear factors into partial fractions.
Learning Outcomes	Students can decompose a simple rational expression with distinct linear factors into partial fractions.
Skills Developed	Algebraic manipulation, Systematic reasoning, Checking strategies
Prerequisites	Algebraic Fractions — Operations & Simplification — Class 10.
Foundation (L1)	Set up the correct partial fraction form for a rational expression with two distinct linear factors.
Advanced (L2)	Find the unknown constants in a partial fraction decomposition.
Challenge (L3)	Decompose a rational expression with three distinct linear factors, verifying by recombining.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Partial fractions with distinct linear factors in the denominator
Question Bank Boundary — Should NOT Test	Partial fractions with repeated or quadratic factors (see A-Level)

3. Polynomial Division

Topic Code	OL-AL-03
Domain	Algebra
Subtopics	Long division of polynomials • Synthetic division (introductory) • Expressing results as quotient and remainder
Concept Description	Students divide polynomials using long division, expressing the result as a quotient and remainder.
Learning Outcomes	Students can divide a polynomial by a linear or quadratic divisor and express the result correctly.
Skills Developed	Algebraic manipulation, Procedural fluency, Systematic reasoning
Prerequisites	Advanced Factorization — Sum/Difference of Cubes (this track).
Foundation (L1)	Divide a cubic polynomial by a linear divisor using long division.
Advanced (L2)	Divide a polynomial by a quadratic divisor.
Challenge (L3)	Use polynomial division as part of a multi-step problem involving the remainder or factor theorem.
Visual Priority	Low

Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Polynomial long division by linear and quadratic divisors
Question Bank Boundary — Should NOT Test	Division involving irrational or complex divisors

4. Remainder & Factor Theorem

Topic Code	OL-AL-04
Domain	Algebra
Subtopics	The remainder theorem • The factor theorem • Finding unknown coefficients
Concept Description	Students apply the remainder and factor theorems to evaluate remainders, test factors, and find unknown coefficients.
Learning Outcomes	Students can apply the remainder theorem to find a remainder and the factor theorem to test or find a factor.
Skills Developed	Algebraic reasoning, Formula application, Problem solving
Prerequisites	Polynomial Division (this track).
Foundation (L1)	Use the remainder theorem to find the remainder when a polynomial is divided by a simple linear factor.
Advanced (L2)	Use the factor theorem to determine whether a given linear expression is a factor of a polynomial.
Challenge (L3)	Find an unknown coefficient in a polynomial given that a specific linear expression is a factor.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Remainder and factor theorems for polynomials up to degree 4
Question Bank Boundary — Should NOT Test	Polynomial equations requiring numerical methods

5. Quadratic Functions — Completing the Square & Vertex Form

Topic Code	OL-AL-05
Domain	Algebra
Subtopics	Converting to vertex form • Identifying the vertex and axis of symmetry • Maximum/minimum value problems
Concept Description	Students convert quadratic functions to vertex form by completing the square and use this to identify key features and solve optimization problems.
Learning Outcomes	Students can convert a quadratic to vertex form and use it to find the maximum or minimum value.
Skills Developed	Algebraic manipulation, Optimization, Application
Prerequisites	Quadratic Equations — Formula & Completing the Square — Class 9.
Foundation (L1)	Convert a simple quadratic to vertex form by completing the square.
Advanced (L2)	Use vertex form to state the maximum or minimum value of a quadratic function.

Challenge (L3)	Solve a real-life optimization problem by converting a quadratic model to vertex form.
Visual Priority	High
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Vertex form and its use in optimization problems for quadratics
Question Bank Boundary — Should NOT Test	Optimization requiring calculus (see A-Level)

6. Simultaneous Equations — Three Variables (Introductory)

Topic Code	OL-AL-06
Domain	Algebra
Subtopics	Solving three linear equations in three unknowns • Elimination strategy • Checking solutions
Concept Description	Students solve systems of three linear equations in three unknowns using systematic elimination.
Learning Outcomes	Students can solve a system of three linear equations in three unknowns using elimination.
Skills Developed	Algebraic manipulation, Systematic reasoning, Checking strategies
Prerequisites	Simultaneous Linear Equations — Class 9.
Foundation (L1)	Eliminate one variable from two of three given equations.
Advanced (L2)	Solve a complete system of three linear equations in three unknowns.
Challenge (L3)	Set up and solve a three-variable system from an unfamiliar word problem.
Visual Priority	Low
Recommended Question Types	Missing number, Word problem
Question Bank Boundary — Should Test	Systems of three linear equations in three unknowns solvable by elimination
Question Bank Boundary — Should NOT Test	Systems requiring matrix methods (see A-Level)

Domain: Exponentials & Logarithms

1. Laws of Logarithms — Advanced Applications

Topic Code	OL-EL-01
Domain	Exponentials & Logarithms
Subtopics	Combining multiple logarithm laws • Change of base formula • Simplifying complex logarithmic expressions
Concept Description	Students combine multiple logarithm laws, including the change of base formula, to simplify complex expressions.
Learning Outcomes	Students can simplify a complex logarithmic expression using several laws, including change of base where needed.
Skills Developed	Logarithmic reasoning, Procedural fluency, Algebraic manipulation
Prerequisites	Introduction to Logarithms & Laws of Logarithms — Class 10.

Foundation (L1)	Apply two laws of logarithms in sequence to simplify an expression.
Advanced (L2)	Use the change of base formula to evaluate a logarithm with an uncommon base.
Challenge (L3)	Simplify a logarithmic expression requiring three or more combined laws.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Combined logarithm laws and change of base
Question Bank Boundary — Should NOT Test	Logarithmic differentiation or integration (see A-Level)

2. Exponential & Logarithmic Equations — Combined

Topic Code	OL-EL-02
Domain	Exponentials & Logarithms
Subtopics	Solving exponential equations using logarithms • Solving logarithmic equations using exponentiation • Real-life applications
Concept Description	Students solve exponential equations using logarithms and logarithmic equations using exponentiation, applying these to real-life problems.
Learning Outcomes	Students can solve an exponential equation using logarithms and a logarithmic equation using exponentiation.
Skills Developed	Algebraic manipulation, Logarithmic reasoning, Application
Prerequisites	Laws of Logarithms — Advanced Applications (this track).
Foundation (L1)	Solve a simple exponential equation using logarithms when bases do not match.
Advanced (L2)	Solve a logarithmic equation by converting to exponential form.
Challenge (L3)	Solve a real-life problem (e.g. compound growth, half-life) requiring exponential/logarithmic equation solving.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Exponential/logarithmic equations solved using logarithm and exponentiation methods
Question Bank Boundary — Should NOT Test	Equations requiring calculus-based methods

Domain: Functions

1. Domain & Range — Advanced Reasoning

Topic Code	OL-FN-01
Domain	Functions
Subtopics	Domain restrictions from denominators and roots • Range from graph behaviour • Domain/range of composite functions
Concept Description	Students determine the domain and range of more complex functions, including those with restrictions and composite functions.

Learning Outcomes	Students can determine the domain and range of a function involving a denominator, root, or composition.
Skills Developed	Function reasoning, Algebraic analysis, Graphical reasoning
Prerequisites	Composite Functions; Inverse Functions (Introductory) — Class 10.
Foundation (L1)	Determine the domain of a function with a single denominator restriction.
Advanced (L2)	Determine the domain of a function involving a square root restriction.
Challenge (L3)	Determine the domain and range of a composite function, accounting for restrictions from both component functions.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Graph-based MCQ
Question Bank Boundary — Should Test	Domain/range for rational, root, and composite functions
Question Bank Boundary — Should NOT Test	Domain/range requiring calculus-based analysis

2. Composite & Inverse Functions — Advanced

Topic Code	OL-FN-02
Domain	Functions
Subtopics	Composite functions of three or more functions • Finding inverses of more complex functions • Domain restrictions for inverses
Concept Description	Students work with composite functions of several functions and find inverses of more complex functions, including domain restrictions.
Learning Outcomes	Students can find a composite of several functions and the inverse of a more complex function, stating any domain restriction.
Skills Developed	Function notation, Algebraic manipulation, Reasoning
Prerequisites	Domain & Range — Advanced Reasoning (this track).
Foundation (L1)	Evaluate a composite of three functions for a given input.
Advanced (L2)	Find the inverse of a function involving a fraction.
Challenge (L3)	Find the inverse of a function requiring a domain restriction to ensure it is one-to-one, and state the restriction.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Composite functions of several functions; inverses requiring domain restrictions
Question Bank Boundary — Should NOT Test	Inverses of trigonometric or exponential functions (see A-Level)

3. Polynomial Functions — Graphs & Behaviour

Topic Code	OL-FN-03
Domain	Functions

Subtopics	Sketching cubic and higher-degree graphs • End behaviour • Roots and turning points (qualitative)
Concept Description	Students sketch polynomial function graphs, describing end behaviour and identifying roots and turning points qualitatively.
Learning Outcomes	Students can sketch a polynomial graph from its factorized form, showing roots and correct end behaviour.
Skills Developed	Graphing, Pattern recognition, Interpretation
Prerequisites	Remainder & Factor Theorem (this track).
Foundation (L1)	Sketch a cubic graph given its roots in factorized form.
Advanced (L2)	Describe the end behaviour of a polynomial graph from its degree and leading coefficient.
Challenge (L3)	Sketch a polynomial graph with a repeated root, showing the correct qualitative behaviour at that root.
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Sketching polynomial graphs from factorized form up to degree 4
Question Bank Boundary — Should NOT Test	Exact turning point coordinates requiring calculus (see A-Level)

4. Rational Functions (Introductory)

Topic Code	OL-FN-04
Domain	Functions
Subtopics	Simple rational function graphs • Vertical and horizontal asymptotes (qualitative) • Domain restrictions
Concept Description	Students sketch simple rational function graphs, identifying domain restrictions and asymptotic behaviour qualitatively.
Learning Outcomes	Students can sketch a simple rational function graph and identify its domain restriction and asymptotes.
Skills Developed	Graphing, Function reasoning, Interpretation
Prerequisites	Polynomial Functions — Graphs & Behaviour (this track).
Foundation (L1)	Identify the domain restriction of a simple rational function.
Advanced (L2)	Sketch a simple rational function graph, showing its vertical asymptote.
Challenge (L3)	Identify both vertical and horizontal asymptotes of a simple rational function and sketch its graph accordingly.
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Simple rational functions of the form $1/(x-a)$ or similar
Question Bank Boundary — Should NOT Test	Rational functions requiring formal limit notation (see A-Level)

Domain: Equations & Inequalities

1. Polynomial Equations — Higher Degree

Topic Code	OL-EQ-01
Domain	Equations & Inequalities
Subtopics	Solving cubic equations using the factor theorem • Solving quartic equations (introductory) • Combining factorization methods
Concept Description	Students solve higher-degree polynomial equations using the factor theorem combined with factorization methods.
Learning Outcomes	Students can solve a cubic (or simple quartic) equation using the factor theorem and factorization.
Skills Developed	Algebraic manipulation, Systematic reasoning, Problem solving
Prerequisites	Remainder & Factor Theorem (this track).
Foundation (L1)	Solve a cubic equation given one factor.
Advanced (L2)	Find a factor of a cubic equation by testing values, then solve completely.
Challenge (L3)	Solve a quartic equation that factorizes into a product of a quadratic and two linear factors.
Visual Priority	Low
Recommended Question Types	Missing number, Standard MCQ
Question Bank Boundary — Should Test	Cubic and simple quartic equations solvable by the factor theorem and factorization
Question Bank Boundary — Should NOT Test	Polynomial equations requiring numerical/iterative methods

2. Simultaneous Equations — Graphical & Algebraic Methods

Topic Code	OL-EQ-02
Domain	Equations & Inequalities
Subtopics	Solving graphically • Comparing graphical and algebraic solutions • Interpreting intersection points
Concept Description	Students solve simultaneous equations both graphically and algebraically, interpreting the intersection points found.
Learning Outcomes	Students can solve a system of equations graphically and verify the solution algebraically.
Skills Developed	Graphical reasoning, Algebraic manipulation, Interpretation
Prerequisites	Simultaneous Equations — Linear & Quadratic — Class 10.
Foundation (L1)	Find the intersection point of two given graphs.
Advanced (L2)	Solve a system both graphically and algebraically and confirm the results agree.
Challenge (L3)	Interpret a real-life situation modelled by two intersecting graphs (e.g. break-even analysis).
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Word problem
Question Bank Boundary — Should Test	Graphical and algebraic solutions of linear/quadratic systems

Question Bank Boundary — Should NOT Test	Systems requiring numerical approximation methods

3. Inequalities — Graphical Regions

Topic Code	OL-EQ-03
Domain	Equations & Inequalities
Subtopics	Shading regions for linear inequalities • Combining several inequalities • Linear programming (introductory)
Concept Description	Students represent systems of linear inequalities as graphical regions and solve simple optimization problems.
Learning Outcomes	Students can shade the region satisfying a system of linear inequalities and identify an optimal point within it.
Skills Developed	Graphical reasoning, Representation, Optimization
Prerequisites	Quadratic Inequalities — Class 10.
Foundation (L1)	Shade the region satisfying a single linear inequality.
Advanced (L2)	Shade the region satisfying a system of two or three linear inequalities.
Challenge (L3)	Solve a simple linear programming problem by identifying the optimal point in a feasible region.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Word problem
Question Bank Boundary — Should Test	Graphical regions for systems of linear inequalities; introductory linear programming
Question Bank Boundary — Should NOT Test	Linear programming requiring the formal simplex method

Domain: Sequences & Series

1. Sigma Notation (Introductory)

Topic Code	OL-SQ-01
Domain	Sequences & Series
Subtopics	Meaning of sigma notation • Evaluating a sum given in sigma notation • Writing a series using sigma notation
Concept Description	Students interpret and evaluate sums expressed in sigma notation and express series using sigma notation.
Learning Outcomes	Students can evaluate a sum given in sigma notation and express a given series using sigma notation.
Skills Developed	Notation, Formula application, Representation
Prerequisites	Arithmetic Series — Sum Formula; Geometric Series — Sum Formula — Class 10.
Foundation (L1)	Evaluate a simple sum given in sigma notation by direct expansion.
Advanced (L2)	Express a given arithmetic or geometric series using sigma notation.
Challenge (L3)	Evaluate a sum in sigma notation using the arithmetic or geometric series formula rather than direct expansion.

Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Sigma notation for arithmetic and geometric series
Question Bank Boundary — Should NOT Test	Sigma notation for non-standard series requiring advanced techniques

2. Sequences & Series — Combined Applications

Topic Code	OL-SQ-02
Domain	Sequences & Series
Subtopics	Mixed sequence/series word problems • Multi-step reasoning across sequence types • Real-life financial and scientific contexts
Concept Description	Students solve multi-step problems combining arithmetic and geometric sequence/series concepts in real-life contexts.
Learning Outcomes	Students can solve a multi-step problem combining arithmetic and geometric sequence/series reasoning.
Skills Developed	Problem solving, Mathematical modelling, Application
Prerequisites	Sigma Notation (Introductory) (this track).
Foundation (L1)	Solve a two-step problem using a single sequence/series formula.
Advanced (L2)	Solve a problem requiring both an arithmetic and a geometric series calculation.
Challenge (L3)	Solve an unfamiliar, multi-step sequence/series problem in a financial or scientific context.
Visual Priority	Medium
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Combined sequence/series applications using O-Level concepts
Question Bank Boundary — Should NOT Test	Recursive or non-standard sequences (see A-Level)

Domain: Euclidean Geometry

1. Circle Theorems — Comprehensive Application

Topic Code	OL-GE-01
Domain	Euclidean Geometry
Subtopics	Angle at centre vs circumference • Angles in the same segment • Combining multiple circle theorems
Concept Description	Students apply the full set of circle theorems together to solve multi-step circle geometry problems.
Learning Outcomes	Students can apply the angle-at-centre and angles-in-the-same-segment theorems, combined with other circle facts, to solve a problem.
Skills Developed	Geometric reasoning, Circle properties, Multi-step problem solving
Prerequisites	Circle Geometry — Cyclic Quadrilaterals; Circle Geometry — Tangent-Chord Angle — Class 10.

Foundation (L1)	Apply the angle-at-centre-is-twice-angle-at-circumference theorem directly.
Advanced (L2)	Apply the angles-in-the-same-segment theorem to find a missing angle.
Challenge (L3)	Solve a multi-step problem requiring three or more circle theorems used together.
Visual Priority	High
Recommended Question Types	Geometry MCQ, Proof/reasoning question
Question Bank Boundary — Should Test	Full comprehensive application of standard circle theorems together
Question Bank Boundary — Should NOT Test	Formal axiomatic proofs of the theorems themselves

2. Congruence & Similarity — Formal Proof

Topic Code	OL-GE-02
Domain	Euclidean Geometry
Subtopics	Formal two-column-style proofs • Congruence proofs in multi-step figures • Similarity proofs with justification
Concept Description	Students construct formal, clearly structured proofs of congruence and similarity in multi-step figures.
Learning Outcomes	Students can construct a formal, clearly structured proof of a congruence or similarity claim.
Skills Developed	Proof construction, Geometric reasoning, Communication
Prerequisites	Multi-Step Geometric Proof — Class 10.
Foundation (L1)	Complete a partially-given formal congruence proof.
Advanced (L2)	Construct a formal proof of congruence for a given pair of triangles.
Challenge (L3)	Construct a formal proof of similarity in an unfamiliar multi-step figure.
Visual Priority	High
Recommended Question Types	Proof/reasoning question, Geometry MCQ
Question Bank Boundary — Should Test	Formal, structured congruence and similarity proofs
Question Bank Boundary — Should NOT Test	Proofs requiring vector or coordinate methods (see those topics)

3. Geometric Proof — Multi-Theorem Problems

Topic Code	OL-GE-03
Domain	Euclidean Geometry
Subtopics	Combining circle, triangle and polygon theorems • Structuring a long-form proof • Communicating a rigorous justification
Concept Description	Students construct rigorous, multi-theorem geometric proofs combining circle, triangle and polygon results.
Learning Outcomes	Students can construct a rigorous proof combining three or more different geometric theorems.
Skills Developed	Proof construction, Geometric reasoning, Communication

Prerequisites	Congruence & Similarity — Formal Proof (this track); Circle Theorems — Comprehensive Application (this track).
Foundation (L1)	Identify which theorems are needed for each step of a given multi-step proof.
Advanced (L2)	Construct a proof combining two different theorem types (e.g. circle and triangle).
Challenge (L3)	Construct an original rigorous proof for an unfamiliar diagram requiring three or more theorems.
Visual Priority	High
Recommended Question Types	Proof/reasoning question, Geometry MCQ
Question Bank Boundary — Should Test	Rigorous multi-theorem proofs using O-Level geometry results
Question Bank Boundary — Should NOT Test	Proofs requiring trigonometric identities

4. Constructions & Loci — Advanced

Topic Code	OL-GE-04
Domain	Euclidean Geometry
Subtopics	Constructions combining multiple conditions • Loci in real-life contexts • Shading regions satisfying multiple loci conditions
Concept Description	Students perform advanced constructions and solve loci problems combining multiple conditions in real-life contexts.
Learning Outcomes	Students can construct and shade a region satisfying two or more combined loci conditions in a real-life context.
Skills Developed	Spatial reasoning, Precision, Application
Prerequisites	Constructions & Loci (Introductory) — Class 10.
Foundation (L1)	Construct a locus satisfying a single condition in a real-life context (e.g. a safety zone).
Advanced (L2)	Construct a region satisfying two combined loci conditions.
Challenge (L3)	Solve a real-life problem requiring construction and shading of a region satisfying three combined conditions.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Word problem
Question Bank Boundary — Should Test	Advanced constructions and multi-condition loci in real-life contexts
Question Bank Boundary — Should NOT Test	Loci requiring formal coordinate equations (see Coordinate Geometry)

5. Three-Dimensional Geometry (Introductory)

Topic Code	OL-GE-05
Domain	Euclidean Geometry
Subtopics	3D Pythagorean theorem applications • Angles between a line and a plane • Angles between two planes (introductory)
Concept Description	Students apply the Pythagorean theorem and trigonometry to three-dimensional geometric problems.

Learning Outcomes	Students can find a missing length or angle in a three-dimensional figure using Pythagoras and/or trigonometry.
Skills Developed	Spatial reasoning, Formula application, Multi-step problem solving
Prerequisites	Pythagorean Theorem & Applications — Class 9; Right-Triangle Trigonometry — Class 9.
Foundation (L1)	Find the length of a space diagonal of a cuboid using the 3D Pythagorean theorem.
Advanced (L2)	Find the angle between a line and a plane in a simple 3D solid.
Challenge (L3)	Solve a multi-step 3D problem combining length and angle calculations in an unfamiliar solid.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Word problem
Question Bank Boundary — Should Test	3D length and angle problems in cuboids, pyramids and prisms
Question Bank Boundary — Should NOT Test	3D problems requiring vector methods (see Vectors track topics)

Domain: Coordinate Geometry

1. Equation of a Circle — Advanced

Topic Code	OL-CG-01
Domain	Coordinate Geometry
Subtopics	General form of a circle equation • Finding centre/radius by completing the square • Intersections with lines
Concept Description	Students convert the general form of a circle's equation to standard form and find intersections with lines.
Learning Outcomes	Students can find the centre and radius of a circle from its general equation and find its intersection with a line.
Skills Developed	Algebraic manipulation, Coordinate reasoning, Problem solving
Prerequisites	Equation of a Circle (Introductory) — Class 10.
Foundation (L1)	Complete the square to convert a circle's general equation to standard form.
Advanced (L2)	Find the points of intersection between a circle and a straight line.
Challenge (L3)	Determine whether a line intersects, is tangent to, or misses a circle, using the discriminant.
Visual Priority	High
Recommended Question Types	Standard MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	General form circle equations and line-circle intersections
Question Bank Boundary — Should NOT Test	Circle equations in parametric form (see A-Level)

2. Tangent to a Circle — Coordinate Methods

Topic Code	OL-CG-02
Domain	Coordinate Geometry

Subtopics	Finding the equation of a tangent at a given point • Using the perpendicular-to-radius property • Tangent length from an external point
Concept Description	Students find the equation of a tangent to a circle at a given point and calculate tangent lengths from external points.
Learning Outcomes	Students can find the equation of a tangent to a circle at a given point using coordinate methods.
Skills Developed	Coordinate reasoning, Algebraic manipulation, Application
Prerequisites	Equation of a Circle — Advanced (this track).
Foundation (L1)	Find the gradient of the radius to a given point on a circle.
Advanced (L2)	Find the equation of the tangent to a circle at a given point on its circumference.
Challenge (L3)	Find the length of a tangent from an external point to a circle using the distance formula.
Visual Priority	High
Recommended Question Types	Standard MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Tangent equations and tangent lengths using coordinate methods
Question Bank Boundary — Should NOT Test	Tangent problems requiring calculus-based gradient of a curve

3. Perpendicular Bisector & Loci

Topic Code	OL-CG-03
Domain	Coordinate Geometry
Subtopics	Equation of a perpendicular bisector • Loci equidistant from a point and a line • Combining coordinate loci with geometric proof
Concept Description	Students find the equation of a perpendicular bisector and solve coordinate loci problems combining several conditions.
Learning Outcomes	Students can find the equation of a perpendicular bisector and use it to solve a coordinate loci problem.
Skills Developed	Coordinate reasoning, Algebraic manipulation, Problem solving
Prerequisites	Geometric Loci on the Coordinate Plane — Class 10.
Foundation (L1)	Find the equation of the perpendicular bisector of a segment joining two given points.
Advanced (L2)	Use a perpendicular bisector to find a point equidistant from two given points satisfying an additional condition.
Challenge (L3)	Solve a multi-step coordinate loci problem combining a perpendicular bisector with a circle or another line.
Visual Priority	High
Recommended Question Types	Standard MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Perpendicular bisector equations and combined coordinate loci problems
Question Bank Boundary — Should NOT Test	Loci requiring parametric or vector equations (see A-Level)

4. Coordinate Geometry — Multi-Step Proof

Topic Code	OL-CG-04
Domain	Coordinate Geometry
Subtopics	Combining distance, gradient, circle and line facts • Structuring a rigorous coordinate proof • Communicating a complete justification
Concept Description	Students construct rigorous, multi-step coordinate proofs combining distance, gradient, circle and line properties.
Learning Outcomes	Students can construct a rigorous multi-step coordinate proof combining several coordinate geometry facts.
Skills Developed	Coordinate reasoning, Proof construction, Communication
Prerequisites	Coordinate Geometry Proofs — Class 10; Tangent to a Circle — Coordinate Methods (this track).
Foundation (L1)	Complete a partially-given coordinate proof combining two facts.
Advanced (L2)	Construct a coordinate proof combining three facts (e.g. distance, gradient and circle equation).
Challenge (L3)	Construct an original rigorous coordinate proof for an unfamiliar configuration.
Visual Priority	High
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Rigorous multi-step coordinate proofs using O-Level coordinate geometry
Question Bank Boundary — Should NOT Test	Proofs requiring vector notation (see Vectors track topics)

Domain: Mensuration

1. Surface Area & Volume — Advanced Composite Solids

Topic Code	OL-MN-01
Domain	Mensuration
Subtopics	Complex composite solids • Missing-dimension problems with multiple unknowns • Real-life engineering-style contexts
Concept Description	Students calculate surface area and volume of complex composite solids, including problems with multiple unknown dimensions.
Learning Outcomes	Students can calculate the surface area or volume of a complex composite solid, solving for more than one missing dimension if needed.
Skills Developed	Spatial reasoning, Formula application, Multi-step problem solving
Prerequisites	Composite Solids — Advanced Problems — Class 10.
Foundation (L1)	Calculate the volume of a composite solid formed from three or more basic solids.
Advanced (L2)	Find a missing dimension in a complex composite solid given a partial measurement.
Challenge (L3)	Solve a real-life engineering-style problem requiring surface area and volume reasoning together.
Visual Priority	High
Recommended Question Types	Word problem, Picture-based MCQ
Question Bank Boundary — Should Test	Complex composite solids combining three or more basic shapes

Question Bank Boundary — Should NOT Test	Composite solids requiring calculus-based volume derivation

2. Mensuration in 3D Coordinate Contexts

Topic Code	OL-MN-02
Domain	Mensuration
Subtopics	Combining mensuration with coordinate geometry • Volume/surface area of solids defined by coordinates • Real-life applications
Concept Description	Students combine mensuration formulas with coordinate geometry to solve problems involving solids defined by coordinate information.
Learning Outcomes	Students can calculate a length, area or volume for a solid where key dimensions are derived from coordinate information.
Skills Developed	Spatial reasoning, Coordinate reasoning, Multi-step problem solving
Prerequisites	Surface Area & Volume — Advanced Composite Solids (this track); Distance, Midpoint & Gradient — Class 9.
Foundation (L1)	Use the distance formula to find a length needed for a mensuration calculation.
Advanced (L2)	Calculate the area of a shape whose vertices are given as coordinates.
Challenge (L3)	Solve a multi-step problem combining coordinate distance calculations with a volume or surface area formula.
Visual Priority	High
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Mensuration problems combined with coordinate geometry techniques
Question Bank Boundary — Should NOT Test	Problems requiring vector cross-product area methods (see A-Level)

Domain: Trigonometry

1. Trigonometric Identities (Introductory)

Topic Code	OL-TR-01
Domain	Trigonometry
Subtopics	$\sin^2\theta+\cos^2\theta=1$ • $\tan\theta=\sin\theta/\cos\theta$ • Simplifying expressions using identities
Concept Description	Students apply the fundamental trigonometric identities to simplify expressions and verify simple relationships.
Learning Outcomes	Students can use a fundamental trigonometric identity to simplify an expression or verify a relationship.
Skills Developed	Trigonometric reasoning, Algebraic manipulation, Verification
Prerequisites	Trigonometric Graphs (Introductory) — Class 10.
Foundation (L1)	Use $\sin^2\theta+\cos^2\theta=1$ to find $\cos\theta$ given $\sin\theta$, or vice versa.
Advanced (L2)	Simplify a trigonometric expression using the identity $\tan\theta=\sin\theta/\cos\theta$.
Challenge (L3)	Verify a simple trigonometric identity by manipulating both sides using known identities.

Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	The two fundamental identities and their direct applications
Question Bank Boundary — Should NOT Test	Compound angle or double angle identities (see A-Level)

2. Trigonometric Equations (Introductory)

Topic Code	OL-TR-02
Domain	Trigonometry
Subtopics	Solving $\sin\theta=k$, $\cos\theta=k$, $\tan\theta=k$ • Multiple solutions in a given range • Using the graph to check solutions
Concept Description	Students solve simple trigonometric equations for all solutions within a given range, using graphs to verify.
Learning Outcomes	Students can solve a simple trigonometric equation and find all solutions within a given range.
Skills Developed	Trigonometric reasoning, Algebraic manipulation, Verification
Prerequisites	Trigonometric Identities (Introductory) (this track).
Foundation (L1)	Solve $\sin\theta=k$ or $\cos\theta=k$ for one solution in the range 0°–360°.
Advanced (L2)	Find all solutions of a simple trigonometric equation within 0°–360°.
Challenge (L3)	Solve a trigonometric equation requiring identity substitution before solving (e.g. using $\sin^2\theta+\cos^2\theta=1$).
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Missing number
Question Bank Boundary — Should Test	Trigonometric equations solvable directly or with one identity substitution, within 0°–360°
Question Bank Boundary — Should NOT Test	General solutions beyond 0°–360° (see A-Level)

3. Graphs of Sine, Cosine & Tangent

Topic Code	OL-TR-03
Domain	Trigonometry
Subtopics	Full graphs of sine, cosine and tangent • Key features including asymptotes of tangent • Reading and comparing graphs
Concept Description	Students sketch and interpret the full graphs of sine, cosine and tangent, including the asymptotic behaviour of tangent.
Learning Outcomes	Students can sketch the graph of tangent alongside sine and cosine, identifying key differences in behaviour.
Skills Developed	Graphing, Pattern recognition, Comparison
Prerequisites	Trigonometric Graphs (Introductory) — Class 10.
Foundation (L1)	Identify the period and key features of a tangent graph.

Advanced (L2)	Sketch the graph of tangent over 0°–360°, showing its asymptotes.
Challenge (L3)	Compare the graphs of sine, cosine and tangent to solve a problem about where two functions are equal.
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Graphs of sine, cosine and tangent over 0°–360°
Question Bank Boundary — Should NOT Test	Graph transformations of trigonometric functions (see A-Level)

4. Bearings & 3D Trigonometry

Topic Code	OL-TR-04
Domain	Trigonometry
Subtopics	Combining bearings with the sine/cosine rule • 3D angle of elevation/depression problems • Multi-step navigation problems
Concept Description	Students combine bearings and three-dimensional trigonometric reasoning using the sine and cosine rules.
Learning Outcomes	Students can solve a multi-step bearings or 3D trigonometry problem using the sine or cosine rule.
Skills Developed	Trigonometric reasoning, Spatial reasoning, Multi-step problem solving
Prerequisites	Sine Rule; Cosine Rule — Class 10; Bearings — Class 9.
Foundation (L1)	Combine a bearing problem with the sine rule to find a missing distance.
Advanced (L2)	Solve a 3D angle of elevation problem requiring the cosine rule.
Challenge (L3)	Solve a multi-leg navigation problem combining bearings, the sine rule and the cosine rule.
Visual Priority	High
Recommended Question Types	Word problem, Picture-based MCQ
Question Bank Boundary — Should Test	Bearings and 3D trigonometry combined with sine/cosine rule
Question Bank Boundary — Should NOT Test	Problems requiring vector-based 3D methods (see A-Level)

5. Sine/Cosine Rule — Advanced Applications

Topic Code	OL-TR-05
Domain	Trigonometry
Subtopics	Multi-step triangle problems • Combining with the area formula • Real-life surveying and navigation problems
Concept Description	Students apply the sine and cosine rules together with the trigonometric area formula in advanced, multi-step problems.
Learning Outcomes	Students can solve an advanced multi-step problem combining the sine rule, cosine rule and area formula.
Skills Developed	Trigonometric reasoning, Multi-step problem solving, Application

Prerequisites	Area of a Triangle Using Trigonometry — Class 10.
Foundation (L1)	Solve a two-step problem combining the sine rule and the area formula.
Advanced (L2)	Solve a problem requiring the cosine rule followed by the sine rule (or vice versa).
Challenge (L3)	Solve a real-life surveying or navigation problem combining all three trigonometric tools in an unfamiliar context.
Visual Priority	High
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Advanced multi-step problems combining sine rule, cosine rule and area formula
Question Bank Boundary — Should NOT Test	Problems requiring vector or calculus-based methods

Domain: Statistics

1. Standard Deviation — Advanced Calculation

Topic Code	OL-ST-01
Domain	Statistics
Subtopics	Standard deviation for grouped data • Using the standard formula/computational formula • Interpreting standard deviation in context
Concept Description	Students calculate the standard deviation of grouped data and interpret it in real-life contexts.
Learning Outcomes	Students can calculate the standard deviation of grouped data and interpret its meaning in context.
Skills Developed	Data analysis, Formula application, Interpretation
Prerequisites	Variance & Standard Deviation (Introductory) — Class 10.
Foundation (L1)	Calculate the standard deviation of grouped data using midpoints.
Advanced (L2)	Use a computational formula to calculate standard deviation efficiently.
Challenge (L3)	Interpret and compare standard deviations across two grouped data sets in a real-life context.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Data interpretation
Question Bank Boundary — Should Test	Standard deviation calculation for grouped data
Question Bank Boundary — Should NOT Test	Standard deviation requiring calculus-based derivation

2. Correlation & Scatter Diagrams

Topic Code	OL-ST-02
Domain	Statistics
Subtopics	Constructing scatter diagrams • Describing correlation (type and strength) • Line of best fit (by eye)
Concept Description	Students construct scatter diagrams, describe correlation, and draw a line of best fit by eye.

Learning Outcomes	Students can construct a scatter diagram, describe the correlation shown, and draw a line of best fit.
Skills Developed	Data representation, Interpretation, Communication
Prerequisites	Comparing Distributions — Class 10.
Foundation (L1)	Construct a scatter diagram from paired data.
Advanced (L2)	Describe the type and strength of correlation shown in a scatter diagram.
Challenge (L3)	Draw a line of best fit and use it to make and critique a prediction, including its limitations.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Data interpretation
Question Bank Boundary — Should Test	Scatter diagrams, correlation description, and line of best fit by eye
Question Bank Boundary — Should NOT Test	Formal regression equation calculation (see next topic)

3. Regression Concepts (Introductory)

Topic Code	OL-ST-03
Domain	Statistics
Subtopics	Meaning of a regression line • Using a given regression equation • Interpretation and limitations of prediction
Concept Description	Students interpret and use a given linear regression equation to make predictions, understanding its limitations.
Learning Outcomes	Students can use a given regression equation to make a prediction and discuss its limitations (interpolation vs extrapolation).
Skills Developed	Data interpretation, Application, Critical thinking
Prerequisites	Correlation & Scatter Diagrams (this track).
Foundation (L1)	Substitute into a given regression equation to make a prediction.
Advanced (L2)	Distinguish between interpolation and extrapolation when using a regression equation.
Challenge (L3)	Critique the reliability of a prediction made using extrapolation far outside the data range.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Data interpretation
Question Bank Boundary — Should Test	Using and interpreting a given regression equation, including interpolation/extrapolation
Question Bank Boundary — Should NOT Test	Deriving the regression equation using least squares calculus

4. Comparing & Interpreting Complex Data Sets

Topic Code	OL-ST-04
Domain	Statistics
Subtopics	Multi-measure comparison of complex data sets • Combining statistics with critical thinking • Justified real-world conclusions

Concept Description	Students compare complex data sets using multiple statistical measures and construct justified, critical conclusions.
Learning Outcomes	Students can compare complex data sets using several statistical measures and construct a justified, critical conclusion.
Skills Developed	Data analysis, Critical thinking, Communication
Prerequisites	Standard Deviation — Advanced Calculation; Regression Concepts (Introductory) (this track).
Foundation (L1)	Compare two complex data sets using one statistical measure.
Advanced (L2)	Compare two complex data sets using several measures together (e.g. mean, standard deviation, correlation).
Challenge (L3)	Construct a justified, critical real-world conclusion combining several statistical measures and their limitations.
Visual Priority	Medium
Recommended Question Types	Data interpretation, Multi-step problem
Question Bank Boundary — Should Test	Multi-measure comparison and justified conclusions using O-Level statistics
Question Bank Boundary — Should NOT Test	Formal statistical hypothesis testing

Domain: Probability

1. Conditional Probability — Formal Treatment

Topic Code	OL-PR-01
Domain	Probability
Subtopics	Formal notation P(A|B) • The conditional probability formula • Applications across contexts
Concept Description	Students use formal conditional probability notation and the conditional probability formula to solve problems.
Learning Outcomes	Students can use the formula $P(A\|B) = P(A\cap B)/P(B)$ to calculate a conditional probability.
Skills Developed	Probability reasoning, Formula application, Application
Prerequisites	Conditional Probability (Introductory) — Class 10.
Foundation (L1)	Calculate $P(A\cap B)$ and $P(B)$ from given information, then find $P(A\|B)$.
Advanced (L2)	Use the conditional probability formula in a two-way table context.
Challenge (L3)	Solve a multi-step problem requiring the conditional probability formula combined with the multiplication rule.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Data interpretation
Question Bank Boundary — Should Test	Formal conditional probability notation and formula
Question Bank Boundary — Should NOT Test	Bayes' theorem in fully general form (see A-Level enrichment)

2. Independent & Dependent Events — Advanced

Topic Code	OL-PR-02
Domain	Probability
Subtopics	Testing for independence using the formula • Dependent event problems • Multi-stage combined problems
Concept Description	Students test whether events are independent using the formula $P(A \cap B)=P(A)\times P(B)$ and solve dependent event problems.
Learning Outcomes	Students can test whether two events are independent using the formula and solve a related dependent-event problem.
Skills Developed	Probability reasoning, Formula application, Classification
Prerequisites	Conditional Probability — Formal Treatment (this track).
Foundation (L1)	Use the independence formula to test whether two given events are independent.
Advanced (L2)	Solve a probability problem involving dependent events, using conditional probability.
Challenge (L3)	Solve a multi-stage problem combining independence testing with conditional probability calculation.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Logical reasoning
Question Bank Boundary — Should Test	Testing independence formally; dependent event problems
Question Bank Boundary — Should NOT Test	Problems requiring formal probability distribution theory (see A-Level)

3. Expected Value (Introductory)

Topic Code	OL-PR-03
Domain	Probability
Subtopics	Meaning of expected value • Calculating expected value for a simple discrete scenario • Interpreting expected value in decision-making
Concept Description	Students calculate the expected value of a simple discrete scenario and interpret it as a long-run average.
Learning Outcomes	Students can calculate the expected value of a simple game or scenario and interpret its meaning.
Skills Developed	Probability reasoning, Formula application, Interpretation
Prerequisites	Independent & Dependent Events — Advanced (this track).
Foundation (L1)	Calculate the expected value of a simple scenario with two outcomes.
Advanced (L2)	Calculate the expected value of a scenario with three or more outcomes.
Challenge (L3)	Use expected value to compare two decision options and justify which is better in the long run.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Expected value for simple discrete scenarios
Question Bank Boundary — Should NOT Test	Formal probability distribution variance (see A-Level)

Domain: Combinatorics & Counting

1. Permutations — Advanced (with Restrictions)

Topic Code	OL-CO-01
Domain	Combinatorics & Counting
Subtopics	Permutations with items grouped together • Permutations with items never together • Permutations with repeated items
Concept Description	Students solve advanced permutation problems involving grouping, exclusion and repeated-item restrictions.
Learning Outcomes	Students can solve a permutation problem with a grouping, exclusion, or repeated-item restriction.
Skills Developed	Combinatorial reasoning, Systematic thinking, Problem solving
Prerequisites	Permutations (Introductory) — Class 10.
Foundation (L1)	Calculate permutations where a specific pair of items must be adjacent.
Advanced (L2)	Calculate permutations where a specific pair of items must never be adjacent (using complementary counting).
Challenge (L3)	Calculate permutations of a set with repeated items (e.g. letters of a word with repeats).
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Logical reasoning
Question Bank Boundary — Should Test	Permutations with grouping, exclusion or repetition restrictions
Question Bank Boundary — Should NOT Test	Circular permutations (enrichment only, not core)

2. Combinations — Advanced (with Restrictions)

Topic Code	OL-CO-02
Domain	Combinatorics & Counting
Subtopics	Combinations with required inclusions/exclusions • Combinations split across groups • Complementary counting for combinations
Concept Description	Students solve advanced combination problems involving required inclusions, exclusions, and complementary counting.
Learning Outcomes	Students can solve a combination problem with an inclusion, exclusion, or complementary counting requirement.
Skills Developed	Combinatorial reasoning, Systematic thinking, Problem solving
Prerequisites	Combinations (Introductory) — Class 10.
Foundation (L1)	Calculate combinations where a specific item must be included.
Advanced (L2)	Calculate combinations where a specific item must be excluded.
Challenge (L3)	Solve a combination problem requiring selection from two or more distinct groups with a combined condition.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Logical reasoning

Question Bank Boundary — Should Test	Combinations with inclusion/exclusion and multi-group selection
Question Bank Boundary — Should NOT Test	Combinations with repetition (multichoose) beyond core scope

3. Combinatorial Problem Solving

Topic Code	OL-CO-03
Domain	Combinatorics & Counting
Subtopics	Choosing between permutations and combinations in complex scenarios • Multi-step counting problems • Combining counting with probability
Concept Description	Students solve complex, multi-step combinatorial problems, correctly choosing between permutation and combination methods.
Learning Outcomes	Students can solve a complex counting problem, correctly determining whether permutations, combinations, or both are needed.
Skills Developed	Combinatorial reasoning, Strategic thinking, Problem solving
Prerequisites	Permutations — Advanced; Combinations — Advanced (this track).
Foundation (L1)	Solve a two-step problem requiring one permutation and one combination calculation.
Advanced (L2)	Solve a multi-step counting problem combining several restrictions.
Challenge (L3)	Solve an unfamiliar competition-style combinatorial puzzle combining counting with probability.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Logical reasoning
Question Bank Boundary — Should Test	Complex multi-step combinatorial problems built from O-Level concepts
Question Bank Boundary — Should NOT Test	Problems requiring generating functions or advanced combinatorial identities

Domain: Vectors

1. Vector Geometry — Ratio of Line Segments

Topic Code	OL-VE-01
Domain	Vectors
Subtopics	Dividing a line segment in a given ratio using vectors • Finding position vectors of division points • Applications to geometric figures
Concept Description	Students use vectors to find the position vector of a point dividing a line segment in a given ratio.
Learning Outcomes	Students can use vectors to find the position vector of a point dividing a segment in a given ratio.
Skills Developed	Vector reasoning, Algebraic manipulation, Application
Prerequisites	Vector Addition & Position Vectors — Class 10.
Foundation (L1)	Find the position vector of the midpoint of a segment using vectors.
Advanced (L2)	Find the position vector of a point dividing a segment in a given ratio other than 1:1.
Challenge (L3)	Use vector ratio division to solve a geometric problem within a more complex figure (e.g. a triangle with cevians).

Visual Priority	High
Recommended Question Types	Picture-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Vector division of a line segment in a given ratio
Question Bank Boundary — Should NOT Test	Vector problems requiring three-dimensional coordinates (see A-Level)

2. Vector Proofs — Collinearity & Parallelism

Topic Code	OL-VE-02
Domain	Vectors
Subtopics	Proving three points are collinear using vectors • Proving two segments are parallel • Structuring a vector proof
Concept Description	Students construct vector proofs of collinearity and parallelism, structuring the argument clearly.
Learning Outcomes	Students can construct a vector proof that three points are collinear or that two segments are parallel.
Skills Developed	Vector reasoning, Proof construction, Communication
Prerequisites	Vector Geometry — Ratio of Line Segments (this track).
Foundation (L1)	Show that two given vectors are parallel (one is a scalar multiple of the other).
Advanced (L2)	Prove that three given points are collinear using vectors.
Challenge (L3)	Construct a complete vector proof combining collinearity and ratio reasoning in an unfamiliar figure.
Visual Priority	High
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Vector proofs of collinearity and parallelism
Question Bank Boundary — Should NOT Test	Vector proofs requiring the dot/scalar product (see A-Level)

Domain: Mathematical Logic, Proof & Reasoning

1. Formal Mathematical Proof — Direct & by Contradiction (Introductory)

Topic Code	OL-LR-01
Domain	Mathematical Logic, Proof & Reasoning
Subtopics	Structuring a formal direct proof • Introductory proof by contradiction • Choosing and justifying a proof method
Concept Description	Students construct formal direct proofs and introductory proofs by contradiction, justifying their choice of method.
Learning Outcomes	Students can construct a formal direct proof and a simple introductory proof by contradiction.
Skills Developed	Proof construction, Logical reasoning, Communication
Prerequisites	Direct & Indirect Reasoning — Class 10.

Foundation (L1)	Construct a formal direct proof of a stated algebraic or number claim.
Advanced (L2)	Construct a simple proof by contradiction (e.g. proving √2 is irrational is a classic model, but use an accessible O-Level-appropriate claim).
Challenge (L3)	Choose between direct proof and proof by contradiction for an unfamiliar claim and justify the choice.
Visual Priority	Low
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Formal direct proofs; introductory proof by contradiction using O-Level-appropriate claims
Question Bank Boundary — Should NOT Test	Proof by mathematical induction (see A-Level)

2. Advanced Logical & Algebraic Reasoning

Topic Code	OL-LR-02
Domain	Mathematical Logic, Proof & Reasoning
Subtopics	Multi-condition logical puzzles at O-Level • Combining algebra with logical deduction • Strategic problem-solving
Concept Description	Students combine algebraic manipulation with logical deduction to solve advanced multi-condition puzzles.
Learning Outcomes	Students can combine algebraic manipulation with logical deduction to solve an advanced multi-condition puzzle.
Skills Developed	Logical reasoning, Algebraic manipulation, Strategic thinking
Prerequisites	Formal Mathematical Proof — Direct & by Contradiction (Introductory) (this track).
Foundation (L1)	Solve a puzzle using algebra to represent one logical condition.
Advanced (L2)	Solve a puzzle combining two algebraic conditions with logical deduction.
Challenge (L3)	Solve an unfamiliar competition-style puzzle combining several algebraic and logical conditions.
Visual Priority	Medium
Recommended Question Types	Logical reasoning, Standard MCQ
Question Bank Boundary — Should Test	Advanced puzzles built from O-Level algebra and logic
Question Bank Boundary — Should NOT Test	Puzzles requiring formal symbolic logic notation

Domain: Problem Solving & Mathematical Modelling

1. Advanced Multi-Step Problem Solving

Topic Code	OL-PS-01
Domain	Problem Solving & Mathematical Modelling
Subtopics	Problems combining several O-Level domains • Advanced planning strategies • Rigorous self-checking

Concept Description	Students solve advanced multi-step problems combining several O-Level domains, planning and rigorously checking their approach.
Learning Outcomes	Students can plan, solve and rigorously check an advanced multi-step problem combining several O-Level domains.
Skills Developed	Problem solving, Strategic thinking, Self-checking
Prerequisites	Broad O-Level topic base.
Foundation (L1)	Solve a two-domain advanced problem with familiar numbers.
Advanced (L2)	Solve a problem combining three domains (e.g. trigonometry, algebra and geometry).
Challenge (L3)	Solve an unfamiliar problem combining four or more O-Level domains.
Visual Priority	Medium
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Advanced multi-step, multi-domain problems built from O-Level concepts
Question Bank Boundary — Should NOT Test	Problems requiring calculus or A-Level-only concepts

2. Mathematical Modelling — Optimization (Introductory)

Topic Code	OL-PS-02
Domain	Problem Solving & Mathematical Modelling
Subtopics	Setting up an optimization model • Solving using vertex form or graphical methods • Evaluating the model's assumptions
Concept Description	Students set up and solve introductory optimization models using vertex form or graphical methods, evaluating assumptions.
Learning Outcomes	Students can set up an optimization model from a real-life situation and solve it using non-calculus methods.
Skills Developed	Mathematical modelling, Optimization, Critical thinking
Prerequisites	Quadratic Functions — Completing the Square & Vertex Form (this track); Inequalities — Graphical Regions (this track).
Foundation (L1)	Set up a simple quadratic model for an optimization scenario (e.g. maximizing area for fixed perimeter).
Advanced (L2)	Solve the optimization model using vertex form or a graphical method.
Challenge (L3)	Evaluate the assumptions of an optimization model and discuss how a changed constraint would affect the solution.
Visual Priority	Medium
Recommended Question Types	Word problem, Standard MCQ
Question Bank Boundary — Should Test	Optimization modelling solvable without calculus (vertex form, graphical, or linear programming methods)
Question Bank Boundary — Should NOT Test	Optimization requiring differentiation (see A-Level)

Markhor Junior Mathematics — Aspirant Level — A-Level

Course Overview

Markhor Junior Mathematics — Aspirant Level — A-Level represents the most advanced academic tier of the Markhor Junior Contest. Students study genuinely advanced pure and applied mathematics: differentiation and integration (including optimization and area between curves), matrices (operations, determinants, solving systems), advanced functions (rigorous domain/range, asymptotic behaviour, combined transformations), exponential and logarithmic modelling, advanced trigonometric identities and general equation solutions, the binomial distribution, expected value and variance, three-dimensional vectors, and rigorous mathematical proof including an introduction to proof by mathematical induction. Advanced mathematical modelling and genuinely non-routine, multi-domain problem solving prepare students for the highest level of competition mathematics within the Markhor Junior Contest.

Mathematical Domains & Topics

Number Systems & Number Theory

- Advanced Number Theory & Proof-Based Reasoning
- Sequences of Primes & Diophantine Reasoning (Enrichment)

Algebra

- Partial Fractions — Full Treatment
- Polynomial Functions — Advanced Factor/Remainder Theorem Applications
- Advanced Algebraic Manipulation & Identities
- Binomial Expansion (Introductory)
- Parametric Relationships (Introductory)

Exponentials & Logarithms

- Exponential Functions — Graphs & Modelling
- Logarithmic Functions — Graphs & Modelling
- Exponential Growth & Decay — Applications

Functions

- Functions — Advanced Domain/Range with Restrictions
- Composite & Inverse Functions — Rigorous Treatment
- Graph Transformations — Combined & Advanced
- Rational Functions — Asymptotic Behaviour
- Modelling with Functions

Equations & Inequalities

- Advanced Equation Solving — Combined Algebraic Methods
- Inequalities — Advanced Regions & Systems

Sequences & Series

- Arithmetic & Geometric Series — Advanced Applications
- Sigma Notation — Formal Treatment
- Series Convergence Concepts (Introductory)
- Recursive Sequences & Modelling

Euclidean Geometry

- Advanced Euclidean Geometry — Rigorous Proof
- Circle Geometry — Comprehensive Theorem Application
- Three-Dimensional Geometric Reasoning

Coordinate Geometry

- Equation of a Circle — Advanced Analytical Methods
- Loci & Coordinate Proof — Advanced
- Intersections of Lines & Curves
- Advanced Coordinate Transformations

Mensuration

- Advanced Mensuration — 3D Composite Reasoning

Trigonometry

- Trigonometric Identities — Advanced Proof
- Trigonometric Equations — General Solutions
- Trigonometric Graphs — Advanced Transformations
- Radians & Arc Length (Introductory)
- Applications of Trigonometry in Advanced Contexts

Statistics

- Variance & Standard Deviation — Advanced Treatment
- Probability Distributions — Discrete
- Binomial Distribution
- Statistical Modelling — Assumptions & Limitations

Probability

- Expected Value & Variance of a Distribution
- Advanced Conditional Probability & Independence

Combinatorics & Counting

- Advanced Permutations & Combinations — Complex Restrictions
- Pigeonhole-Style & Combinatorial Reasoning

Vectors

- Vector Geometry — Advanced Proofs
- 3D Vectors (Introductory)
- Vector Applications in Mechanics-Style Contexts (Introductory)

Matrices

- Matrix Notation & Operations
- Determinants & Inverse Matrices
- Solving Systems Using Matrices

Calculus

- Concept of the Derivative & Gradient Functions
- Differentiation Rules — Power, Sum, Constant
- Product Rule & Quotient Rule
- Chain Rule
- Stationary Points & Curve Sketching
- Increasing/Decreasing Functions & Optimization
- Concept of Integration — Antiderivatives
- Definite Integration & Area Under a Curve
- Area Between Two Curves
- Applications of Calculus — Modelling & Rates of Change

Mathematical Logic, Proof & Reasoning

- Rigorous Mathematical Proof — Direct, Contradiction & Induction (Introductory)
- Advanced Counterexamples & Logical Argument
- Critique & Evaluation of Mathematical Arguments

Problem Solving & Mathematical Modelling

- Advanced Mathematical Modelling
- Optimization Problems — Advanced
- Non-Routine Advanced Problem Solving

Detailed Topic-by-Topic Curriculum — A-Level

Domain: Number Systems & Number Theory

1. Advanced Number Theory & Proof-Based Reasoning

Topic Code	AL-NT-01
Domain	Number Systems & Number Theory
Subtopics	Rigorous divisibility proofs • Proof involving prime numbers • Structured multi-step number theory arguments
Concept Description	Students construct rigorous, multi-step proof-based arguments about number properties, including prime-related claims.
Learning Outcomes	Students can construct a rigorous multi-step proof of a number theory claim, including claims involving primes.
Skills Developed	Proof construction, Number theory, Rigorous reasoning
Prerequisites	Number Theory — Modular Reasoning (Introductory) — O-Level.
Foundation (L1)	Construct a direct proof of a straightforward divisibility claim.
Advanced (L2)	Construct a proof involving a claim about prime numbers (e.g. a specific prime cannot divide a given expression).
Challenge (L3)	Construct a rigorous multi-step number theory proof combining several results.
Visual Priority	Low
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Rigorous number theory proofs appropriate to A-Level, without formal number theory notation beyond what has been introduced
Question Bank Boundary — Should NOT Test	Formal number theory requiring university-level notation (e.g. formal modular arithmetic rings)

2. Sequences of Primes & Diophantine Reasoning (Enrichment)

Topic Code	AL-NT-02
Domain	Number Systems & Number Theory
Subtopics	Patterns among primes • Simple Diophantine-style equations • Competition-style number theory puzzles
Concept Description	Students explore patterns among primes and solve competition-style Diophantine-style puzzles as enrichment.
Learning Outcomes	Students can solve a competition-style number theory puzzle involving primes or integer-constrained equations.
Skills Developed	Number theory, Pattern recognition, Strategic reasoning
Prerequisites	Advanced Number Theory & Proof-Based Reasoning (this track).
Foundation (L1)	Investigate a simple pattern among the first several prime numbers.
Advanced (L2)	Solve a Diophantine-style equation with a small, systematically searchable solution set.
Challenge (L3)	Solve an unfamiliar competition-style number theory puzzle combining primes and integer constraints.
Visual Priority	Low

Recommended Question Types	Standard MCQ, Logical reasoning
Question Bank Boundary — Should Test	Enrichment-level prime patterns and Diophantine-style puzzles solvable without advanced theory
Question Bank Boundary — Should NOT Test	Formal theorems (e.g. the Prime Number Theorem) requiring university-level analysis

Domain: Algebra

1. Partial Fractions — Full Treatment

Topic Code	AL-AL-01
Domain	Algebra
Subtopics	Repeated linear factors • Irreducible quadratic factors • Improper fractions (introductory)
Concept Description	Students decompose rational expressions into partial fractions, including repeated linear and quadratic factors.
Learning Outcomes	Students can decompose a rational expression with a repeated linear factor or an irreducible quadratic factor into partial fractions.
Skills Developed	Algebraic manipulation, Systematic reasoning, Procedural fluency
Prerequisites	Partial Fractions (Introductory) — O-Level.
Foundation (L1)	Set up the correct partial fraction form for an expression with a repeated linear factor.
Advanced (L2)	Find the unknown constants for a partial fraction decomposition with a repeated linear factor.
Challenge (L3)	Decompose an expression with an irreducible quadratic factor, or an improper fraction requiring prior division.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Partial fractions with repeated linear and irreducible quadratic factors, including improper fractions
Question Bank Boundary — Should NOT Test	Partial fractions requiring complex-number factorization

2. Polynomial Functions — Advanced Factor/Remainder Theorem Applications

Topic Code	AL-AL-02
Domain	Algebra
Subtopics	Multi-step polynomial problems • Finding multiple unknown coefficients • Combining with inequalities or graphs
Concept Description	Students apply the factor and remainder theorems to multi-step polynomial problems, finding several unknown coefficients.
Learning Outcomes	Students can solve a multi-step polynomial problem requiring the factor/remainder theorems and find several unknown coefficients.
Skills Developed	Algebraic reasoning, Systematic problem solving, Application
Prerequisites	Remainder & Factor Theorem — O-Level.
Foundation (L1)	Find one unknown coefficient in a polynomial given one factor.

Advanced (L2)	Find two unknown coefficients in a polynomial given two conditions (factors or remainders).
Challenge (L3)	Solve a problem combining the factor theorem with a sketch or inequality about the polynomial's behaviour.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Multi-step factor/remainder theorem problems with multiple unknowns
Question Bank Boundary — Should NOT Test	Problems requiring numerical root-finding methods

3. Advanced Algebraic Manipulation & Identities

Topic Code	AL-AL-03
Domain	Algebra
Subtopics	Manipulating complex rational and surd expressions • Proving algebraic identities • Simplifying multi-layered expressions
Concept Description	Students manipulate complex algebraic expressions and prove algebraic identities using rigorous, structured working.
Learning Outcomes	Students can simplify a complex multi-layered algebraic expression and prove a given algebraic identity.
Skills Developed	Algebraic manipulation, Proof construction, Procedural fluency
Prerequisites	Partial Fractions — Full Treatment (this track).
Foundation (L1)	Simplify a moderately complex algebraic expression combining fractions and surds.
Advanced (L2)	Prove a stated algebraic identity by manipulating one side to match the other.
Challenge (L3)	Simplify or prove an identity involving a multi-layered expression requiring several combined techniques.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Proof/reasoning question
Question Bank Boundary — Should Test	Advanced algebraic manipulation and identity proofs at A-Level standard
Question Bank Boundary — Should NOT Test	Manipulation requiring complex numbers

4. Binomial Expansion (Introductory)

Topic Code	AL-AL-04
Domain	Algebra
Subtopics	Binomial theorem for positive integer powers • Pascal's triangle / binomial coefficients • Finding a specific term
Concept Description	Students apply the binomial theorem to expand expressions of the form $(a+b)^n$ and find a specific term.
Learning Outcomes	Students can expand $(a+b)^n$ using the binomial theorem and find a specific term without full expansion.

Skills Developed	Formula application, Pattern recognition, Procedural fluency
Prerequisites	Algebraic Identities — Advanced Expansion/Factorization — Class 10.
Foundation (L1)	Expand $(a+b)^n$ for a small positive integer n using binomial coefficients.
Advanced (L2)	Find a specific term (e.g. the term in x^3) in a binomial expansion without expanding fully.
Challenge (L3)	Use the binomial theorem to solve a problem involving an unknown coefficient or approximation.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Binomial theorem for positive integer powers
Question Bank Boundary — Should NOT Test	Binomial expansion for negative or fractional powers

5. Parametric Relationships (Introductory)

Topic Code	AL-AL-05
Domain	Algebra
Subtopics	Parametric equations for a curve • Converting to Cartesian form • Simple parametric applications
Concept Description	Students interpret simple parametric equations, converting them to Cartesian form where appropriate.
Learning Outcomes	Students can convert a simple pair of parametric equations to Cartesian form.
Skills Developed	Algebraic manipulation, Representation, Coordinate reasoning
Prerequisites	Equation of a Circle — Advanced — O-Level.
Foundation (L1)	Evaluate a pair of parametric equations for a given parameter value.
Advanced (L2)	Eliminate the parameter from a simple pair of parametric equations to find the Cartesian equation.
Challenge (L3)	Interpret the shape traced by a set of parametric equations and identify key features.
Visual Priority	High
Recommended Question Types	Standard MCQ, Graph-based MCQ
Question Bank Boundary — Should Test	Simple parametric equations convertible to Cartesian form
Question Bank Boundary — Should NOT Test	Parametric differentiation (enrichment only, beyond core A-Level calculus scope)

Domain: Exponentials & Logarithms

1. Exponential Functions — Graphs & Modelling

Topic Code	AL-EL-01
Domain	Exponentials & Logarithms

Subtopics	Graphing exponential functions • Key features (asymptote, intercept) • Modelling real-life exponential growth/decay
Concept Description	Students graph exponential functions, identify their key features, and use them to model real-life growth and decay.
Learning Outcomes	Students can sketch an exponential function graph and use it to model a real-life growth or decay situation.
Skills Developed	Graphing, Mathematical modelling, Application
Prerequisites	Exponential & Logarithmic Equations — Combined — O-Level.
Foundation (L1)	Sketch the graph of a basic exponential function, showing its asymptote and y-intercept.
Advanced (L2)	Use an exponential model to predict a value at a given time.
Challenge (L3)	Evaluate the assumptions and limitations of an exponential model in an unfamiliar real-life context.
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Word problem
Question Bank Boundary — Should Test	Exponential function graphs and real-life growth/decay modelling
Question Bank Boundary — Should NOT Test	Modelling requiring differential equations (see Calculus enrichment)

2. Logarithmic Functions — Graphs & Modelling

Topic Code	AL-EL-02
Domain	Exponentials & Logarithms
Subtopics	Graphing logarithmic functions • Key features (asymptote, intercept) • Relationship to exponential graphs
Concept Description	Students graph logarithmic functions, identify their key features, and relate them to exponential function graphs.
Learning Outcomes	Students can sketch a logarithmic function graph and describe its relationship to the corresponding exponential graph.
Skills Developed	Graphing, Function reasoning, Interpretation
Prerequisites	Exponential Functions — Graphs & Modelling (this track).
Foundation (L1)	Sketch the graph of a basic logarithmic function, showing its asymptote and x-intercept.
Advanced (L2)	Describe the reflective relationship between a logarithmic graph and its corresponding exponential graph.
Challenge (L3)	Use a logarithmic graph to solve an equation graphically and verify algebraically.
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Logarithmic function graphs and their relationship to exponential graphs
Question Bank Boundary — Should NOT Test	Graphs requiring calculus-based curve sketching techniques (covered separately in Calculus)

3. Exponential Growth & Decay — Applications

Topic Code	AL-EL-03
Domain	Exponentials & Logarithms
Subtopics	Compound growth/decay models • Half-life and doubling-time problems • Multi-step real-life applications
Concept Description	Students apply exponential growth and decay models to multi-step real-life problems, including half-life and doubling time.
Learning Outcomes	Students can solve a multi-step real-life problem involving exponential growth, decay, half-life or doubling time.
Skills Developed	Mathematical modelling, Problem solving, Application
Prerequisites	Logarithmic Functions — Graphs & Modelling (this track).
Foundation (L1)	Calculate a future value given an exponential growth or decay rate.
Advanced (L2)	Solve for the half-life or doubling time of an exponential decay/growth model.
Challenge (L3)	Solve an unfamiliar multi-step problem combining exponential modelling with logarithmic equation solving.
Visual Priority	Medium
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Multi-step exponential growth/decay applications including half-life/doubling time
Question Bank Boundary — Should NOT Test	Continuous growth models requiring the constant e and calculus (enrichment only)

Domain: Functions

1. Functions — Advanced Domain/Range with Restrictions

Topic Code	AL-FN-01
Domain	Functions
Subtopics	Domain/range for combined restrictions • Piecewise-defined functions (introductory) • Justifying domain/range rigorously
Concept Description	Students determine domain and range for functions with combined restrictions and simple piecewise definitions, justifying rigorously.
Learning Outcomes	Students can determine and rigorously justify the domain and range of a function with combined or piecewise restrictions.
Skills Developed	Function reasoning, Rigorous justification, Algebraic analysis
Prerequisites	Domain & Range — Advanced Reasoning — O-Level.
Foundation (L1)	Determine the domain of a function with two combined restrictions (e.g. denominator and root).
Advanced (L2)	Determine the domain and range of a simple piecewise-defined function.
Challenge (L3)	Rigorously justify the domain and range of an unfamiliar function combining several restriction types.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Proof/reasoning question
Question Bank Boundary — Should Test	Advanced domain/range reasoning including simple piecewise functions

Question Bank Boundary — Should NOT Test	Domain/range requiring formal limit or continuity analysis

2. Composite & Inverse Functions — Rigorous Treatment

Topic Code	AL-FN-02
Domain	Functions
Subtopics	Proving two functions are inverses • Rigorous domain restriction for invertibility • Composite/inverse function graphs
Concept Description	Students rigorously prove that two functions are inverses of each other and justify domain restrictions required for invertibility.
Learning Outcomes	Students can rigorously prove that two given functions are inverses and justify any domain restriction required.
Skills Developed	Function notation, Rigorous justification, Algebraic manipulation
Prerequisites	Composite & Inverse Functions — Advanced — O-Level.
Foundation (L1)	Verify that two functions are inverses by showing f(g(x))=x and g(f(x))=x.
Advanced (L2)	Determine and justify the domain restriction needed for a given function to have an inverse.
Challenge (L3)	Rigorously prove an inverse relationship for an unfamiliar function, including full domain justification.
Visual Priority	Medium
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Rigorous proof of inverse relationships and domain restriction justification
Question Bank Boundary — Should NOT Test	Inverse functions requiring calculus-based derivative of the inverse

3. Graph Transformations — Combined & Advanced

Topic Code	AL-FN-03
Domain	Functions
Subtopics	Stretches (vertical and horizontal) • Combining translation, reflection and stretch • Describing a sequence of transformations
Concept Description	Students apply and describe combined graph transformations, including stretches, in the correct order.
Learning Outcomes	Students can sketch the graph resulting from a combination of transformations applied in a specified order.
Skills Developed	Graphing, Function notation, Communication
Prerequisites	Graph Transformations — Translations & Reflections — Class 10.
Foundation (L1)	Sketch a single stretch (vertical or horizontal) of a given function.
Advanced (L2)	Sketch the graph resulting from two combined transformations applied in sequence.
Challenge (L3)	Describe, in correct order and using function notation, the sequence of three or more transformations mapping one graph to another.
Visual Priority	High

Recommended Question Types	Graph-based MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Combined transformations including stretches, applied in a specified order
Question Bank Boundary — Should NOT Test	Transformations of implicitly-defined or parametric curves

4. Rational Functions — Asymptotic Behaviour

Topic Code	AL-FN-04
Domain	Functions
Subtopics	Vertical and horizontal asymptotes (rigorous) • Oblique asymptotes (introductory) • Sketching using asymptotic behaviour
Concept Description	Students rigorously identify vertical, horizontal and (introductory) oblique asymptotes of rational functions and sketch their graphs.
Learning Outcomes	Students can identify the asymptotes of a rational function and use them to sketch its graph.
Skills Developed	Graphing, Algebraic analysis, Function reasoning
Prerequisites	Rational Functions (Introductory) — O-Level.
Foundation (L1)	Identify the vertical and horizontal asymptotes of a given rational function.
Advanced (L2)	Sketch a rational function graph using its asymptotes and intercepts.
Challenge (L3)	Identify an oblique asymptote for a rational function where the numerator's degree exceeds the denominator's by one.
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Vertical/horizontal asymptotes rigorously; introductory oblique asymptotes
Question Bank Boundary — Should NOT Test	Asymptotic analysis requiring formal limit notation

5. Modelling with Functions

Topic Code	AL-FN-05
Domain	Functions
Subtopics	Choosing an appropriate function type to model data • Fitting a function to a real-life context • Evaluating model fit and limitations
Concept Description	Students select and fit an appropriate function type to model real-life data or contexts, evaluating the model's limitations.
Learning Outcomes	Students can select an appropriate function type for a given real-life context and evaluate the resulting model's limitations.
Skills Developed	Mathematical modelling, Critical thinking, Application
Prerequisites	Modelling with Functions draws on Exponential Functions — Graphs & Modelling; Polynomial Functions — Graphs & Behaviour (O-Level).
Foundation (L1)	Match a described real-life context to the most appropriate function type (linear, quadratic, exponential).

Advanced (L2)	Fit a simple function to given data points and use it to make a prediction.
Challenge (L3)	Evaluate why a chosen function model may fail to fit a real-life context well, and suggest an alternative.
Visual Priority	Medium
Recommended Question Types	Word problem, Standard MCQ
Question Bank Boundary — Should Test	Function modelling and evaluation using A-Level function types (excluding calculus-based fitting)
Question Bank Boundary — Should NOT Test	Statistical regression modelling (see Statistics track)

Domain: Equations & Inequalities

1. Advanced Equation Solving — Combined Algebraic Methods

Topic Code	AL-EQ-01
Domain	Equations & Inequalities
Subtopics	Equations requiring several combined techniques • Equations involving surds, indices and logarithms together • Systematic multi-step solving
Concept Description	Students solve advanced equations requiring several combined algebraic techniques in a single multi-step solution.
Learning Outcomes	Students can solve an advanced equation requiring several combined techniques (e.g. surds, indices, logarithms together).
Skills Developed	Algebraic manipulation, Systematic problem solving, Checking strategies
Prerequisites	Broad A-Level algebra, exponentials and logarithms base.
Foundation (L1)	Solve an equation requiring two combined techniques.
Advanced (L2)	Solve an equation requiring three combined techniques in sequence.
Challenge (L3)	Solve an unfamiliar equation requiring careful strategic planning across several techniques, checking for extraneous solutions.
Visual Priority	Low
Recommended Question Types	Missing number, Standard MCQ
Question Bank Boundary — Should Test	Advanced multi-technique equation solving using A-Level algebra, exponentials and logarithms
Question Bank Boundary — Should NOT Test	Equations requiring numerical/iterative methods

2. Inequalities — Advanced Regions & Systems

Topic Code	AL-EQ-02
Domain	Equations & Inequalities
Subtopics	Inequalities involving rational expressions • Systems combining linear and quadratic inequalities • Advanced graphical regions
Concept Description	Students solve advanced inequalities, including those involving rational expressions, and represent complex combined regions.

Learning Outcomes	Students can solve an inequality involving a rational expression and represent a complex combined inequality region.
Skills Developed	Algebraic manipulation, Graphical reasoning, Representation
Prerequisites	Inequalities — Graphical Regions — O-Level; Quadratic Inequalities — Class 10.
Foundation (L1)	Solve a simple rational inequality using critical values and a sign diagram.
Advanced (L2)	Represent a system combining a linear and a quadratic inequality graphically.
Challenge (L3)	Solve an unfamiliar problem requiring a complex combined inequality region with three or more conditions.
Visual Priority	High
Recommended Question Types	Picture-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Rational inequalities and complex combined inequality systems
Question Bank Boundary — Should NOT Test	Inequalities requiring calculus-based sign analysis of derivatives

Domain: Sequences & Series

1. Arithmetic & Geometric Series — Advanced Applications

Topic Code	AL-SQ-01
Domain	Sequences & Series
Subtopics	Combined multi-step series problems • Series with an unknown parameter • Real-life financial and scientific modelling
Concept Description	Students solve advanced multi-step series problems, including those with an unknown parameter, in real-life modelling contexts.
Learning Outcomes	Students can solve an advanced series problem involving an unknown parameter or combined arithmetic/geometric reasoning.
Skills Developed	Formula application, Algebraic reasoning, Mathematical modelling
Prerequisites	Sequences & Series — Combined Applications — O-Level.
Foundation (L1)	Solve a series problem requiring the sum formula with one unknown parameter.
Advanced (L2)	Solve a problem combining an arithmetic and geometric series in the same real-life scenario.
Challenge (L3)	Solve an unfamiliar, multi-parameter series problem in a financial or scientific modelling context.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Advanced series applications including unknown-parameter problems
Question Bank Boundary — Should NOT Test	Series requiring formal generating functions

2. Sigma Notation — Formal Treatment

Topic Code	AL-SQ-02

Domain	Sequences & Series
Subtopics	Formal manipulation of sigma notation • Splitting and combining sums • Standard sum formulas (Σn, Σn^2) — introductory
Concept Description	Students formally manipulate sigma notation, including splitting, combining, and using standard sum formulas.
Learning Outcomes	Students can formally manipulate a sum in sigma notation, including splitting it into simpler sums.
Skills Developed	Notation, Algebraic manipulation, Formula application
Prerequisites	Sigma Notation (Introductory) — O-Level.
Foundation (L1)	Split a sum in sigma notation into two simpler sums.
Advanced (L2)	Use a standard formula (e.g. for Σn) to evaluate a sum in sigma notation.
Challenge (L3)	Evaluate a sum in sigma notation requiring a combination of standard formulas and algebraic manipulation.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Formal sigma notation manipulation, including standard sum formulas
Question Bank Boundary — Should NOT Test	Sigma notation requiring formal proof by induction (see Logic & Reasoning)

3. Series Convergence Concepts (Introductory)

Topic Code	AL-SQ-03
Domain	Sequences & Series
Subtopics	Meaning of convergence for a geometric series • Condition $\|r\|<1$ • Qualitative discussion of convergence/divergence
Concept Description	Students discuss, at an introductory level, the convergence of a geometric series and the significance of the condition $\|r\|<1$.
Learning Outcomes	Students can state the condition for convergence of a geometric series and use it to determine whether a sum to infinity exists.
Skills Developed	Conceptual understanding, Reasoning, Application
Prerequisites	Geometric Series — Sum Formula — Class 10.
Foundation (L1)	State whether a given geometric series converges based on its common ratio.
Advanced (L2)	Explain, qualitatively, why a geometric series with $\|r\|\geq 1$ does not have a finite sum.
Challenge (L3)	Determine the range of a parameter for which a given geometric series converges.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Proof/reasoning question
Question Bank Boundary — Should Test	Introductory, qualitative convergence concepts for geometric series only
Question Bank Boundary — Should NOT Test	Formal epsilon-delta convergence proofs (university-level analysis)

4. Recursive Sequences & Modelling

Topic Code	AL-SQ-04
Domain	Sequences & Series
Subtopics	Recursive (recurrence) definitions • Generating terms from a recursive rule • Modelling real-life recursive situations
Concept Description	Students generate terms from recursively defined sequences and use recursive models for real-life situations.
Learning Outcomes	Students can generate terms from a recursive sequence definition and use one to model a real-life situation.
Skills Developed	Pattern recognition, Mathematical modelling, Application
Prerequisites	Sequence Rules — Algebraic Representation — Pioneer Level (Class 8).
Foundation (L1)	Generate the first several terms of a sequence from a recursive rule.
Advanced (L2)	Use a recursive model to predict a term several steps ahead by iterating the rule.
Challenge (L3)	Build and interpret a recursive model for an unfamiliar real-life situation (e.g. population with a changing rate).
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Recursive sequences and their use in modelling, without formal closed-form derivation
Question Bank Boundary — Should NOT Test	Solving recurrence relations using formal characteristic equations

Domain: Euclidean Geometry

1. Advanced Euclidean Geometry — Rigorous Proof

Topic Code	AL-GE-01
Domain	Euclidean Geometry
Subtopics	Rigorous multi-step Euclidean proofs • Combining several theorem types • Communicating a fully justified argument
Concept Description	Students construct rigorous, fully justified multi-step Euclidean proofs combining several different theorem types.
Learning Outcomes	Students can construct a rigorous, fully justified Euclidean proof combining several different theorems.
Skills Developed	Proof construction, Geometric reasoning, Communication
Prerequisites	Geometric Proof — Multi-Theorem Problems — O-Level.
Foundation (L1)	Complete a partially-given rigorous proof combining two theorem types.
Advanced (L2)	Construct a rigorous proof combining three theorem types for a given figure.
Challenge (L3)	Construct an original rigorous proof for an unfamiliar, complex figure requiring several theorems and careful justification.
Visual Priority	High
Recommended Question Types	Proof/reasoning question, Geometry MCQ

Question Bank Boundary — Should Test	Rigorous, fully justified multi-theorem Euclidean proofs at A-Level standard
Question Bank Boundary — Should NOT Test	Proofs requiring axiomatic set theory or formal logic notation

2. Circle Geometry — Comprehensive Theorem Application

Topic Code	AL-GE-02
Domain	Euclidean Geometry
Subtopics	All standard circle theorems combined • Multi-step circle proofs • Applications in unfamiliar configurations
Concept Description	Students apply the complete set of circle theorems together in multi-step proofs and unfamiliar configurations.
Learning Outcomes	Students can apply the complete set of circle theorems together to solve or prove a result in an unfamiliar configuration.
Skills Developed	Geometric reasoning, Circle properties, Proof construction
Prerequisites	Circle Theorems — Comprehensive Application — O-Level.
Foundation (L1)	Apply two circle theorems together in a moderately complex diagram.
Advanced (L2)	Apply three or more circle theorems together to solve a multi-step problem.
Challenge (L3)	Construct a complete proof for an unfamiliar circle configuration requiring careful theorem selection.
Visual Priority	High
Recommended Question Types	Proof/reasoning question, Geometry MCQ
Question Bank Boundary — Should Test	Comprehensive application of circle theorems in unfamiliar, complex configurations
Question Bank Boundary — Should NOT Test	Circle geometry requiring inversive or projective methods

3. Three-Dimensional Geometric Reasoning

Topic Code	AL-GE-03
Domain	Euclidean Geometry
Subtopics	Advanced 3D angle and length problems • Combining trigonometry, Pythagoras and vectors in 3D • Rigorous justification in 3D contexts
Concept Description	Students solve advanced three-dimensional geometric problems combining trigonometry, the Pythagorean theorem and vector methods.
Learning Outcomes	Students can solve an advanced 3D geometric problem, combining trigonometric, Pythagorean and vector reasoning as needed.
Skills Developed	Spatial reasoning, Multi-method problem solving, Rigorous justification
Prerequisites	Three-Dimensional Geometry (Introductory) — O-Level; 3D Vectors (Introductory) (this track).
Foundation (L1)	Solve a 3D length problem using the Pythagorean theorem in an unfamiliar solid.
Advanced (L2)	Solve a 3D angle problem combining trigonometry with the Pythagorean theorem.
Challenge (L3)	Solve an advanced 3D problem requiring vector methods combined with trigonometric or Pythagorean reasoning.

Visual Priority	High
Recommended Question Types	Picture-based MCQ, Word problem
Question Bank Boundary — Should Test	Advanced 3D reasoning combining trigonometry, Pythagoras and vectors
Question Bank Boundary — Should NOT Test	3D geometry requiring formal differential geometry

Domain: Coordinate Geometry

1. Equation of a Circle — Advanced Analytical Methods

Topic Code	AL-CG-01
Domain	Coordinate Geometry
Subtopics	Circles defined by three points • Families of circles (introductory) • Advanced tangent and intersection problems
Concept Description	Students use advanced analytical methods to find the equation of a circle through three points and solve complex tangent/intersection problems.
Learning Outcomes	Students can find the equation of a circle passing through three given points.
Skills Developed	Coordinate reasoning, Algebraic manipulation, Systematic problem solving
Prerequisites	Equation of a Circle — Advanced; Tangent to a Circle — Coordinate Methods — O-Level.
Foundation (L1)	Set up the system of equations needed to find a circle through three given points.
Advanced (L2)	Solve the system to find the equation of a circle through three given points.
Challenge (L3)	Solve an advanced problem involving a family of circles satisfying a given condition.
Visual Priority	High
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Advanced analytical circle equation problems including three-point circles
Question Bank Boundary — Should NOT Test	Circles requiring polar coordinate representation

2. Loci & Coordinate Proof — Advanced

Topic Code	AL-CG-02
Domain	Coordinate Geometry
Subtopics	Complex loci combining circles, lines and parabolas • Rigorous coordinate proofs of advanced results • Multi-condition loci problems
Concept Description	Students solve complex loci problems combining several curve types and construct rigorous coordinate proofs of advanced results.
Learning Outcomes	Students can solve a complex loci problem combining several curve types and construct a rigorous coordinate proof.
Skills Developed	Coordinate reasoning, Proof construction, Systematic problem solving
Prerequisites	Coordinate Geometry — Multi-Step Proof — O-Level.

Foundation (L1)	Find the equation of a locus combining a circle condition with a linear condition.
Advanced (L2)	Construct a rigorous coordinate proof of an advanced geometric result.
Challenge (L3)	Solve an unfamiliar multi-condition loci problem combining three or more coordinate geometry concepts.
Visual Priority	High
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Advanced loci and rigorous coordinate proofs combining multiple curve types
Question Bank Boundary — Should NOT Test	Loci requiring polar or parametric-only representations beyond introductory parametric topic

3. Intersections of Lines & Curves

Topic Code	AL-CG-03
Domain	Coordinate Geometry
Subtopics	Intersections of a line with a circle or polynomial curve • Using the discriminant to classify intersections • Real-life applications
Concept Description	Students find and classify the intersections of a line with a circle or polynomial curve using algebraic and discriminant methods.
Learning Outcomes	Students can find the intersection points of a line with a curve and use the discriminant to classify the number of intersections.
Skills Developed	Algebraic manipulation, Coordinate reasoning, Classification
Prerequisites	Equation of a Circle — Advanced Analytical Methods (this track).
Foundation (L1)	Find the intersection points of a line with a simple quadratic curve.
Advanced (L2)	Use the discriminant to determine whether a line intersects a circle in zero, one or two points.
Challenge (L3)	Solve a real-life problem requiring classification of intersections between a line and an unfamiliar curve.
Visual Priority	High
Recommended Question Types	Standard MCQ, Graph-based MCQ
Question Bank Boundary — Should Test	Line-curve intersections and discriminant-based classification
Question Bank Boundary — Should NOT Test	Intersections requiring numerical/iterative solution methods

4. Advanced Coordinate Transformations

Topic Code	AL-CG-04
Domain	Coordinate Geometry
Subtopics	Combining transformations with coordinate geometry • Transformed equations of curves • Applications to circles and lines
Concept Description	Students find the equations of transformed curves (translated, reflected, scaled) using coordinate geometry methods.
Learning Outcomes	Students can find the equation of a curve after a given transformation has been applied.

Skills Developed	Coordinate reasoning, Algebraic manipulation, Function/graph reasoning
Prerequisites	Graph Transformations — Combined & Advanced (this track).
Foundation (L1)	Find the equation of a circle after a simple translation.
Advanced (L2)	Find the equation of a line or circle after a reflection or scaling.
Challenge (L3)	Find the equation of a curve after a combination of two or more transformations.
Visual Priority	High
Recommended Question Types	Standard MCQ, Graph-based MCQ
Question Bank Boundary — Should Test	Equations of transformed lines and circles under combined transformations
Question Bank Boundary — Should NOT Test	Transformations requiring matrix representation (see Matrices topics for that method)

Domain: Mensuration

1. Advanced Mensuration — 3D Composite Reasoning

Topic Code	AL-MN-01
Domain	Mensuration
Subtopics	Highly complex composite solids • Combining mensuration with trigonometry and vectors • Real-life advanced applications
Concept Description	Students solve highly complex mensuration problems combining composite solids with trigonometric and vector reasoning.
Learning Outcomes	Students can solve an advanced mensuration problem combining composite solid calculations with trigonometric or vector methods.
Skills Developed	Spatial reasoning, Multi-method problem solving, Application
Prerequisites	Surface Area & Volume — Advanced Composite Solids — O-Level; Three-Dimensional Geometric Reasoning (this track).
Foundation (L1)	Calculate the volume of a highly complex composite solid with several component shapes.
Advanced (L2)	Solve a mensuration problem requiring a trigonometric calculation to find a needed dimension first.
Challenge (L3)	Solve an unfamiliar advanced problem combining mensuration, trigonometry and vector reasoning together.
Visual Priority	High
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Advanced composite mensuration combined with trigonometry/vectors at A-Level standard
Question Bank Boundary — Should NOT Test	Volume calculations requiring integral calculus (kept separate under Calculus)

Domain: Trigonometry

1. Trigonometric Identities — Advanced Proof

Topic Code	AL-TR-01
Domain	Trigonometry
Subtopics	Compound angle identities • Double angle identities • Proving more advanced identities
Concept Description	Students apply compound and double angle identities and use them to prove more advanced trigonometric identities.
Learning Outcomes	Students can apply a compound or double angle identity and use it to prove a more advanced trigonometric identity.
Skills Developed	Trigonometric reasoning, Proof construction, Algebraic manipulation
Prerequisites	Trigonometric Identities (Introductory) — O-Level.
Foundation (L1)	Use a double angle identity to find $\sin(2\theta)$ or $\cos(2\theta)$ given $\sin\theta$ or $\cos\theta$.
Advanced (L2)	Use a compound angle identity to expand $\sin(A\pm B)$ or $\cos(A\pm B)$.
Challenge (L3)	Prove an advanced trigonometric identity requiring compound and double angle identities together.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Proof/reasoning question
Question Bank Boundary — Should Test	Compound angle and double angle identities and their use in proofs
Question Bank Boundary — Should NOT Test	Identities requiring complex exponential (Euler's formula) representation

2. Trigonometric Equations — General Solutions

Topic Code	AL-TR-02
Domain	Trigonometry
Subtopics	General solution formulas • Solving equations for all solutions (not just 0°–360°) • Equations requiring identity substitution
Concept Description	Students find general solutions to trigonometric equations and solve equations requiring identity substitution first.
Learning Outcomes	Students can find the general solution to a trigonometric equation and solve one requiring identity substitution.
Skills Developed	Trigonometric reasoning, Algebraic manipulation, Systematic reasoning
Prerequisites	Trigonometric Equations (Introductory) — O-Level; Trigonometric Identities — Advanced Proof (this track).
Foundation (L1)	Find the general solution of a simple equation such as $\sin\theta=k$.
Advanced (L2)	Solve a trigonometric equation requiring a double angle identity substitution first.
Challenge (L3)	Solve an unfamiliar trigonometric equation requiring several combined identities and general solution reasoning.
Visual Priority	High
Recommended Question Types	Missing number, Standard MCQ
Question Bank Boundary — Should Test	General solutions and identity-substitution equations at A-Level standard
Question Bank Boundary — Should NOT Test	Equations requiring complex exponential methods

3. Trigonometric Graphs — Advanced Transformations

Topic Code	AL-TR-03
Domain	Trigonometry
Subtopics	Amplitude and period changes • Phase shifts • Combining transformations of trigonometric graphs
Concept Description	Students sketch trigonometric graphs under combined transformations, including amplitude, period and phase changes.
Learning Outcomes	Students can sketch a trigonometric graph under a combination of amplitude, period and phase transformations.
Skills Developed	Graphing, Function notation, Pattern recognition
Prerequisites	Graphs of Sine, Cosine & Tangent — O-Level; Graph Transformations — Combined & Advanced (this track).
Foundation (L1)	Sketch a sine or cosine graph with a changed amplitude.
Advanced (L2)	Sketch a sine or cosine graph with a changed period and a phase shift.
Challenge (L3)	Sketch a trigonometric graph under a combination of all three transformation types and identify its equation.
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	Combined amplitude, period and phase transformations of trigonometric graphs
Question Bank Boundary — Should NOT Test	Transformations of trigonometric functions in radians requiring calculus context

4. Radians & Arc Length (Introductory)

Topic Code	AL-TR-04
Domain	Trigonometry
Subtopics	Radian measure • Converting between degrees and radians • Arc length and sector area in radians
Concept Description	Students interpret radian measure, convert between degrees and radians, and use radians in arc length and sector area formulas.
Learning Outcomes	Students can convert between degrees and radians and use radian measure in arc length and sector area calculations.
Skills Developed	Notation, Formula application, Conversion
Prerequisites	Arc Length & Sector Area — Class 10.
Foundation (L1)	Convert a given angle in degrees to radians, or vice versa.
Advanced (L2)	Calculate arc length or sector area using the radian versions of the formulas ($s=r\theta$, $A=\frac{1}{2}r^2\theta$).
Challenge (L3)	Solve a multi-step problem involving radian measure combined with trigonometric equation solving.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Missing number

Question Bank Boundary — Should Test	Radian measure, conversion, and radian-based arc length/sector area formulas
Question Bank Boundary — Should NOT Test	Calculus applications of radians (see Calculus track, kept separate)

5. Applications of Trigonometry in Advanced Contexts

Topic Code	AL-TR-05
Domain	Trigonometry
Subtopics	Combining trigonometric identities with sine/cosine rule • Advanced real-life modelling problems • Multi-step competition-style trigonometry
Concept Description	Students apply trigonometric identities, equations and rules together to solve advanced, multi-step real-life and competition-style problems.
Learning Outcomes	Students can solve an advanced multi-step problem combining trigonometric identities, equations and the sine/cosine rules.
Skills Developed	Trigonometric reasoning, Multi-step problem solving, Strategic thinking
Prerequisites	Trigonometric Equations — General Solutions (this track); Sine/Cosine Rule — Advanced Applications — O-Level.
Foundation (L1)	Solve a two-step problem combining an identity with the sine or cosine rule.
Advanced (L2)	Solve a three-step problem requiring an equation, an identity, and a rule together.
Challenge (L3)	Solve an unfamiliar competition-style trigonometry problem combining several tools strategically.
Visual Priority	High
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Advanced multi-tool trigonometric problem solving at A-Level standard
Question Bank Boundary — Should NOT Test	Problems requiring complex-number or hyperbolic trigonometric methods

Domain: Statistics

1. Variance & Standard Deviation — Advanced Treatment

Topic Code	AL-ST-01
Domain	Statistics
Subtopics	Variance/SD for combined data sets • Effect of linear transformations on variance/SD • Advanced interpretation
Concept Description	Students calculate variance and standard deviation for combined data sets and analyze the effect of linear transformations on them.
Learning Outcomes	Students can determine the effect of a linear transformation (e.g. adding a constant, scaling) on the variance and standard deviation of a data set.
Skills Developed	Data analysis, Algebraic reasoning, Interpretation
Prerequisites	Standard Deviation — Advanced Calculation — O-Level.
Foundation (L1)	Calculate the new mean after a linear transformation is applied to a data set.

Advanced (L2)	Determine the new standard deviation after a data set is scaled by a constant.
Challenge (L3)	Solve a problem combining two data sets, finding the combined mean and variance.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Effect of linear transformations on variance/SD; combining data sets
Question Bank Boundary — Should NOT Test	Variance requiring formal continuous probability distribution integration

2. Probability Distributions — Discrete

Topic Code	AL-ST-02
Domain	Statistics
Subtopics	Discrete probability distribution tables • Verifying a valid distribution (probabilities sum to 1) • Calculating probabilities from a distribution
Concept Description	Students construct and use discrete probability distribution tables, verifying validity and calculating probabilities.
Learning Outcomes	Students can construct a discrete probability distribution table and verify it is valid.
Skills Developed	Probability reasoning, Data organization, Verification
Prerequisites	Expected Value (Introductory) — O-Level.
Foundation (L1)	Verify that a given discrete probability distribution is valid (sums to 1).
Advanced (L2)	Find an unknown probability in a distribution table using the sum-to-1 condition.
Challenge (L3)	Construct a full discrete probability distribution table for an unfamiliar scenario and use it to answer a question.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Data interpretation
Question Bank Boundary — Should Test	Discrete probability distributions, verification and basic calculation
Question Bank Boundary — Should NOT Test	Continuous probability distributions requiring integral calculus

3. Binomial Distribution

Topic Code	AL-ST-03
Domain	Statistics
Subtopics	Conditions for a binomial distribution • Binomial probability formula • Mean and variance of a binomial distribution
Concept Description	Students identify situations modelled by a binomial distribution and calculate probabilities, mean and variance.
Learning Outcomes	Students can identify a binomial scenario, calculate a binomial probability, and find the mean and variance of the distribution.
Skills Developed	Probability reasoning, Formula application, Application

Prerequisites	Probability Distributions — Discrete (this track).
Foundation (L1)	Identify whether a scenario satisfies the conditions for a binomial distribution.
Advanced (L2)	Calculate a single binomial probability using the formula.
Challenge (L3)	Find the mean and variance of a binomial distribution and use them to answer a real-life question.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	Binomial distribution conditions, probability calculation, mean and variance
Question Bank Boundary — Should NOT Test	Normal approximation to the binomial or continuous distributions

4. Statistical Modelling — Assumptions & Limitations

Topic Code	AL-ST-04
Domain	Statistics
Subtopics	Identifying assumptions in a statistical model • Evaluating limitations • Communicating a critical evaluation
Concept Description	Students identify the assumptions underlying a statistical model and critically evaluate its limitations.
Learning Outcomes	Students can identify the assumptions of a given statistical model and critically evaluate its limitations in context.
Skills Developed	Critical thinking, Statistical reasoning, Communication
Prerequisites	Comparing & Interpreting Complex Data Sets — O-Level; Binomial Distribution (this track).
Foundation (L1)	State one assumption underlying a given statistical model.
Advanced (L2)	Evaluate whether a given model's assumptions are reasonable for a described real-life context.
Challenge (L3)	Construct a full critical evaluation of an unfamiliar statistical model, including assumptions, limitations and possible improvements.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Proof/reasoning question
Question Bank Boundary — Should Test	Critical evaluation of statistical models within A-Level statistics scope
Question Bank Boundary — Should NOT Test	Formal hypothesis testing or p-value interpretation

Domain: Probability

1. Expected Value & Variance of a Distribution

Topic Code	AL-PR-01
Domain	Probability
Subtopics	Expected value E(X) for a discrete distribution • Variance Var(X) for a discrete distribution • Applications to decision-making

Concept Description	Students calculate the expected value and variance of a discrete probability distribution and apply these to decision-making.
Learning Outcomes	Students can calculate E(X) and Var(X) for a discrete probability distribution and use them to compare scenarios.
Skills Developed	Probability reasoning, Formula application, Application
Prerequisites	Probability Distributions — Discrete (this track).
Foundation (L1)	Calculate E(X) for a simple discrete distribution.
Advanced (L2)	Calculate Var(X) for a simple discrete distribution using $E(X^2) - [E(X)]^2$.
Challenge (L3)	Use E(X) and Var(X) together to compare two decision scenarios and justify a recommendation.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Word problem
Question Bank Boundary — Should Test	E(X) and Var(X) for discrete distributions and their use in comparison
Question Bank Boundary — Should NOT Test	Expected value/variance for continuous distributions

2. Advanced Conditional Probability & Independence

Topic Code	AL-PR-02
Domain	Probability
Subtopics	Multi-stage conditional probability • Bayes'-style reasoning (introductory, without formal theorem name) • Testing independence rigorously
Concept Description	Students solve multi-stage conditional probability problems and rigorously test independence in advanced scenarios.
Learning Outcomes	Students can solve a multi-stage conditional probability problem and rigorously test independence of events.
Skills Developed	Probability reasoning, Rigorous reasoning, Application
Prerequisites	Conditional Probability — Formal Treatment — O-Level; Independent & Dependent Events — Advanced — O-Level.
Foundation (L1)	Solve a two-stage conditional probability problem using a tree diagram.
Advanced (L2)	Solve a problem requiring reversal of conditioning (finding $P(A\|B)$ from $P(B\|A)$) using basic principles.
Challenge (L3)	Solve an unfamiliar multi-stage problem combining conditional probability with independence testing.
Visual Priority	High
Recommended Question Types	Data interpretation, Standard MCQ
Question Bank Boundary — Should Test	Advanced multi-stage conditional probability and rigorous independence testing
Question Bank Boundary — Should NOT Test	Bayes' theorem stated or applied in fully formal generalized form

Domain: Combinatorics & Counting

1. Advanced Permutations & Combinations — Complex Restrictions

Topic Code	AL-CO-01
Domain	Combinatorics & Counting
Subtopics	Multiple combined restrictions • Permutations/combinations across several groups • Strategic problem decomposition
Concept Description	Students solve advanced permutation and combination problems with multiple combined restrictions, decomposing them strategically.
Learning Outcomes	Students can solve an advanced counting problem with multiple combined restrictions by strategically decomposing it.
Skills Developed	Combinatorial reasoning, Strategic thinking, Systematic problem solving
Prerequisites	Combinatorial Problem Solving — O-Level.
Foundation (L1)	Solve a counting problem with two combined restrictions.
Advanced (L2)	Solve a counting problem with three combined restrictions, decomposing into cases.
Challenge (L3)	Solve an unfamiliar competition-style counting problem requiring careful case decomposition and strategic reasoning.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Logical reasoning
Question Bank Boundary — Should Test	Advanced multi-restriction counting problems at A-Level standard
Question Bank Boundary — Should NOT Test	Problems requiring generating functions or inclusion-exclusion in full generality

2. Pigeonhole-Style & Combinatorial Reasoning

Topic Code	AL-CO-02
Domain	Combinatorics & Counting
Subtopics	Pigeonhole principle reasoning • Existence-style combinatorial arguments • Competition-style combinatorial puzzles
Concept Description	Students apply pigeonhole-style reasoning to construct existence arguments in combinatorial and number-theoretic contexts.
Learning Outcomes	Students can construct a pigeonhole-style existence argument to solve a combinatorial or number-theoretic puzzle.
Skills Developed	Logical reasoning, Combinatorial reasoning, Strategic thinking
Prerequisites	Advanced Permutations & Combinations — Complex Restrictions (this track).
Foundation (L1)	Apply the basic pigeonhole principle to a simple existence problem.
Advanced (L2)	Construct a pigeonhole-style argument for a moderately complex scenario.
Challenge (L3)	Solve an unfamiliar competition-style puzzle requiring a non-obvious pigeonhole-style argument.
Visual Priority	Low
Recommended Question Types	Logical reasoning, Proof/reasoning question
Question Bank Boundary — Should Test	Pigeonhole-style reasoning at an accessible, competition-oriented level

Question Bank Boundary — Should NOT Test	Formal generalized pigeonhole theorems requiring advanced combinatorics

Domain: Vectors

1. Vector Geometry — Advanced Proofs

Topic Code	AL-VE-01
Domain	Vectors
Subtopics	Advanced vector proofs of geometric results • Combining ratio, collinearity and parallelism • Rigorous structured argument
Concept Description	Students construct advanced, rigorous vector proofs of geometric results, combining ratio, collinearity and parallelism reasoning.
Learning Outcomes	Students can construct a rigorous vector proof of an advanced geometric result combining several vector techniques.
Skills Developed	Vector reasoning, Proof construction, Rigorous communication
Prerequisites	Vector Proofs — Collinearity & Parallelism — O-Level.
Foundation (L1)	Complete a partially-given advanced vector proof.
Advanced (L2)	Construct a vector proof combining ratio division with collinearity in a moderately complex figure.
Challenge (L3)	Construct an original rigorous vector proof for an unfamiliar geometric configuration.
Visual Priority	High
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Advanced, rigorous vector proofs combining several techniques
Question Bank Boundary — Should NOT Test	Vector proofs requiring the cross/vector product (beyond core scope)

2. 3D Vectors (Introductory)

Topic Code	AL-VE-02
Domain	Vectors
Subtopics	Vectors in three dimensions • Magnitude in 3D • 3D vector addition and position vectors
Concept Description	Students extend vector concepts to three dimensions, calculating magnitude and performing vector operations in 3D.
Learning Outcomes	Students can represent a 3D vector, calculate its magnitude, and perform vector addition/subtraction in three dimensions.
Skills Developed	Vector reasoning, Spatial reasoning, Formula application
Prerequisites	Vector Addition & Position Vectors — Class 10.
Foundation (L1)	Write a 3D vector connecting two given points in column form.
Advanced (L2)	Calculate the magnitude of a 3D vector.
Challenge (L3)	Solve a simple 3D geometric problem using position vectors and vector addition.
Visual Priority	High

Recommended Question Types	Standard MCQ, Picture-based MCQ
Question Bank Boundary — Should Test	3D vector notation, magnitude, addition and position vectors
Question Bank Boundary — Should NOT Test	3D vector problems requiring the cross product

3. Vector Applications in Mechanics-Style Contexts (Introductory)

Topic Code	AL-VE-03
Domain	Vectors
Subtopics	Vectors representing displacement and simple motion • Resultant vectors • Simple real-life vector applications
Concept Description	Students apply vectors to represent displacement and simple motion, calculating resultant vectors in real-life contexts.
Learning Outcomes	Students can use vectors to represent a displacement or simple motion scenario and calculate a resultant vector.
Skills Developed	Vector reasoning, Application, Spatial reasoning
Prerequisites	3D Vectors (Introductory) (this track).
Foundation (L1)	Represent a simple displacement scenario as a vector.
Advanced (L2)	Calculate the resultant of two combined vector displacements.
Challenge (L3)	Solve a multi-step real-life problem (e.g. relative motion) using resultant vector reasoning.
Visual Priority	High
Recommended Question Types	Word problem, Picture-based MCQ
Question Bank Boundary — Should Test	Introductory vector applications to displacement and simple resultant motion
Question Bank Boundary — Should NOT Test	Full mechanics content requiring forces, momentum or formal kinematics equations

Domain: Matrices

1. Matrix Notation & Operations

Topic Code	AL-MA-01
Domain	Matrices
Subtopics	Matrix notation and order • Addition, subtraction and scalar multiplication • Matrix multiplication
Concept Description	Students use matrix notation and perform addition, subtraction, scalar multiplication and matrix multiplication.
Learning Outcomes	Students can perform addition, subtraction, scalar multiplication and multiplication of matrices up to 3×3.
Skills Developed	Matrix operations, Procedural fluency, Notation
Prerequisites	Systematic algebraic manipulation from Algebra strand.
Foundation (L1)	Add or subtract two matrices of the same order.

Advanced (L2)	Multiply two matrices, including a 2×2 by a 2×2.
Challenge (L3)	Perform a multi-step calculation combining several matrix operations, checking that orders are compatible at each step.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Matrix operations up to 3×3, including checking compatibility of orders
Question Bank Boundary — Should NOT Test	Matrices larger than 3×3 or requiring eigenvalues

2. Determinants & Inverse Matrices

Topic Code	AL-MA-02
Domain	Matrices
Subtopics	Determinant of a 2×2 and 3×3 matrix • Condition for a matrix to be invertible • Finding the inverse of a 2×2 matrix
Concept Description	Students calculate determinants of 2×2 and 3×3 matrices and find the inverse of a 2×2 matrix where it exists.
Learning Outcomes	Students can calculate a determinant, determine whether a matrix is invertible, and find the inverse of a 2×2 matrix.
Skills Developed	Formula application, Algebraic reasoning, Procedural fluency
Prerequisites	Matrix Notation & Operations (this track).
Foundation (L1)	Calculate the determinant of a 2×2 matrix.
Advanced (L2)	Find the inverse of a 2×2 matrix using the standard formula.
Challenge (L3)	Determine, using the determinant, whether a given matrix is singular, and interpret what this means.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Determinants of 2×2 and 3×3 matrices; inverse of 2×2 matrices
Question Bank Boundary — Should NOT Test	Inverse of 3×3 matrices requiring cofactor expansion (enrichment only)

3. Solving Systems Using Matrices

Topic Code	AL-MA-03
Domain	Matrices
Subtopics	Representing a linear system as a matrix equation • Solving using the inverse matrix method • Interpreting the solution
Concept Description	Students represent systems of linear equations as matrix equations and solve them using the inverse matrix method.
Learning Outcomes	Students can represent a 2×2 linear system as a matrix equation and solve it using the inverse matrix.

Skills Developed	Matrix operations, Algebraic reasoning, Application
Prerequisites	Determinants & Inverse Matrices (this track); Simultaneous Linear Equations — Class 9.
Foundation (L1)	Write a given 2×2 linear system as a matrix equation.
Advanced (L2)	Solve a 2×2 linear system using the inverse matrix method.
Challenge (L3)	Solve a real-life problem by setting up and solving a matrix equation for a linear system.
Visual Priority	Low
Recommended Question Types	Missing number, Word problem
Question Bank Boundary — Should Test	Matrix methods for solving 2×2 (and, where the determinant is straightforward, 3×3) linear systems
Question Bank Boundary — Should NOT Test	Systems requiring Gaussian elimination formalism

Domain: Calculus

1. Concept of the Derivative & Gradient Functions

Topic Code	AL-CL-01
Domain	Calculus
Subtopics	Gradient of a curve at a point • The derivative as a limiting gradient (conceptual) • Notation dy/dx and f'(x)
Concept Description	Students understand the derivative as the gradient of a curve at a point and interpret standard derivative notation.
Learning Outcomes	Students can interpret the derivative as a gradient function and use standard notation correctly.
Skills Developed	Conceptual understanding, Notation, Graphical reasoning
Prerequisites	Gradient (Slope) — Concept & Calculation — Pioneer Level (Class 8).
Foundation (L1)	Interpret what the derivative of a function represents graphically at a given point.
Advanced (L2)	Estimate the gradient of a curve at a point using a small interval (introductory numerical approach).
Challenge (L3)	Explain, conceptually, why the derivative describes an instantaneous rather than average rate of change.
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Conceptual understanding of the derivative as gradient function, and standard notation
Question Bank Boundary — Should NOT Test	Formal epsilon-delta limit definitions

2. Differentiation Rules — Power, Sum, Constant

Topic Code	AL-CL-02
Domain	Calculus
Subtopics	Power rule • Sum/difference rule • Differentiating polynomial functions

Concept Description	Students apply the power rule and sum/difference rule to differentiate polynomial functions.
Learning Outcomes	Students can differentiate a polynomial function using the power rule and sum/difference rule.
Skills Developed	Differentiation, Procedural fluency, Formula application
Prerequisites	Concept of the Derivative & Gradient Functions (this track).
Foundation (L1)	Differentiate a single power term using the power rule.
Advanced (L2)	Differentiate a polynomial with several terms using the sum/difference rule.
Challenge (L3)	Differentiate a polynomial requiring rewriting first (e.g. expanding brackets or splitting a fraction).
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Power rule and sum/difference rule for polynomial functions
Question Bank Boundary — Should NOT Test	Differentiation of trigonometric, exponential or logarithmic functions (see later topics)

3. Product Rule & Quotient Rule

Topic Code	AL-CL-03
Domain	Calculus
Subtopics	The product rule • The quotient rule • Choosing the correct rule
Concept Description	Students apply the product and quotient rules to differentiate products and quotients of functions.
Learning Outcomes	Students can differentiate a product or quotient of two functions using the appropriate rule.
Skills Developed	Differentiation, Formula application, Strategy selection
Prerequisites	Differentiation Rules — Power, Sum, Constant (this track).
Foundation (L1)	Differentiate a simple product of two polynomial functions using the product rule.
Advanced (L2)	Differentiate a simple quotient of two polynomial functions using the quotient rule.
Challenge (L3)	Differentiate a function requiring a choice between and correct application of the product or quotient rule within a larger expression.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Product and quotient rules for polynomial (and, combined with later topics, other) functions
Question Bank Boundary — Should NOT Test	Differentiation requiring implicit differentiation

4. Chain Rule

Topic Code	AL-CL-04
Domain	Calculus
Subtopics	The chain rule for composite functions • Differentiating $(f(x))^n$ • Combining the chain rule with other rules

Concept Description	Students apply the chain rule to differentiate composite functions, including combining it with the product or quotient rule.
Learning Outcomes	Students can differentiate a composite function using the chain rule, including combined with other rules.
Skills Developed	Differentiation, Formula application, Strategy selection
Prerequisites	Product Rule & Quotient Rule (this track).
Foundation (L1)	Differentiate $(ax+b)^n$ using the chain rule.
Advanced (L2)	Differentiate a composite function requiring the chain rule combined with the sum rule.
Challenge (L3)	Differentiate an expression requiring the chain rule combined with the product or quotient rule.
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Chain rule for polynomial composite functions, combined with other differentiation rules
Question Bank Boundary — Should NOT Test	Chain rule applications requiring trigonometric/exponential/logarithmic derivatives (enrichment extension only)

5. Stationary Points & Curve Sketching

Topic Code	AL-CL-05
Domain	Calculus
Subtopics	Finding stationary points • Classifying maxima, minima and points of inflection • Sketching a curve using calculus information
Concept Description	Students find and classify stationary points of a function and use this information to sketch its graph.
Learning Outcomes	Students can find the stationary points of a function, classify them, and sketch the curve accordingly.
Skills Developed	Differentiation, Classification, Graphing
Prerequisites	Chain Rule (this track).
Foundation (L1)	Find the stationary point(s) of a simple quadratic function by setting the derivative to zero.
Advanced (L2)	Classify a stationary point as a maximum or minimum using the second derivative or sign test.
Challenge (L3)	Sketch a cubic or quartic function using its stationary points, intercepts and end behaviour together.
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Finding and classifying stationary points; curve sketching using calculus information
Question Bank Boundary — Should NOT Test	Points of inflection requiring rigorous formal analysis beyond sign-test classification

6. Increasing/Decreasing Functions & Optimization

Topic Code	AL-CL-06

Domain	Calculus
Subtopics	Determining intervals of increase/decrease • Setting up an optimization problem • Solving using differentiation
Concept Description	Students determine intervals where a function is increasing or decreasing and solve real-life optimization problems using differentiation.
Learning Outcomes	Students can determine where a function is increasing or decreasing and solve an optimization problem using differentiation.
Skills Developed	Differentiation, Mathematical modelling, Problem solving
Prerequisites	Stationary Points & Curve Sketching (this track).
Foundation (L1)	Determine whether a function is increasing or decreasing at a given point using its derivative.
Advanced (L2)	Set up a simple optimization problem (e.g. maximizing area or minimizing cost) as a function of one variable.
Challenge (L3)	Solve a real-life optimization problem fully, from setup through differentiation to interpreting the result in context.
Visual Priority	Medium
Recommended Question Types	Word problem, Standard MCQ
Question Bank Boundary — Should Test	Increasing/decreasing analysis and calculus-based optimization problems
Question Bank Boundary — Should NOT Test	Optimization requiring Lagrange multipliers or multivariable calculus

7. Concept of Integration — Antiderivatives

Topic Code	AL-CL-07
Domain	Calculus
Subtopics	Integration as the reverse of differentiation • Finding the general antiderivative • The constant of integration
Concept Description	Students understand integration as the reverse process of differentiation and find general antiderivatives, including the constant of integration.
Learning Outcomes	Students can find the general antiderivative of a simple polynomial function, including the constant of integration.
Skills Developed	Integration, Conceptual understanding, Procedural fluency
Prerequisites	Differentiation Rules — Power, Sum, Constant (this track).
Foundation (L1)	Find the antiderivative of a single power term.
Advanced (L2)	Find the general antiderivative of a polynomial with several terms, including +C.
Challenge (L3)	Find a specific antiderivative given an initial condition (e.g. a point the curve passes through).
Visual Priority	Low
Recommended Question Types	Standard MCQ, Missing number
Question Bank Boundary — Should Test	Antiderivatives of polynomial functions, including using an initial condition to find C
Question Bank Boundary — Should NOT Test	Integration by substitution or by parts (enrichment extension only)

8. Definite Integration & Area Under a Curve

Topic Code	AL-CL-08
Domain	Calculus
Subtopics	Evaluating a definite integral • Area under a curve using integration • Interpreting the result in context
Concept Description	Students evaluate definite integrals and use them to calculate the area under a curve, interpreting results in context.
Learning Outcomes	Students can evaluate a definite integral and use it to calculate the area under a curve between given limits.
Skills Developed	Integration, Formula application, Interpretation
Prerequisites	Concept of Integration — Antiderivatives (this track).
Foundation (L1)	Evaluate a definite integral of a simple polynomial between given limits.
Advanced (L2)	Use a definite integral to find the area under a curve above the x-axis.
Challenge (L3)	Find the area under a curve that crosses the x-axis, correctly handling the sign of the integral in each region.
Visual Priority	High
Recommended Question Types	Standard MCQ, Graph-based MCQ
Question Bank Boundary — Should Test	Definite integration and area under a curve, including curves crossing the x-axis
Question Bank Boundary — Should NOT Test	Improper integrals or integrals requiring substitution

9. Area Between Two Curves

Topic Code	AL-CL-09
Domain	Calculus
Subtopics	Setting up the integral for the area between two curves • Finding intersection points first • Evaluating the area
Concept Description	Students find the area enclosed between two curves by first finding their intersection points and then integrating the difference.
Learning Outcomes	Students can find the area enclosed between two curves, first finding the relevant intersection points.
Skills Developed	Integration, Algebraic manipulation, Multi-step problem solving
Prerequisites	Definite Integration & Area Under a Curve (this track); Intersections of Lines & Curves (this track).
Foundation (L1)	Find the intersection points of two simple curves algebraically.
Advanced (L2)	Set up and evaluate the integral for the area between a line and a simple curve.
Challenge (L3)	Find the area between two curves that intersect at more than two points, correctly setting up each region.
Visual Priority	High
Recommended Question Types	Graph-based MCQ, Standard MCQ
Question Bank Boundary — Should Test	Area between two curves, including finding intersection points algebraically

Question Bank Boundary — Should NOT Test	Volumes of revolution or areas requiring polar coordinates

10. Applications of Calculus — Modelling & Rates of Change

Topic Code	AL-CL-10
Domain	Calculus
Subtopics	Rates of change in real-life contexts • Kinematic applications (displacement, velocity, acceleration) • Multi-step calculus modelling problems
Concept Description	Students apply differentiation and integration to real-life rate-of-change and introductory kinematic modelling problems.
Learning Outcomes	Students can solve a real-life problem involving rates of change, or an introductory kinematics problem, using calculus.
Skills Developed	Mathematical modelling, Differentiation and integration, Application
Prerequisites	Area Between Two Curves (this track); Increasing/Decreasing Functions & Optimization (this track).
Foundation (L1)	Find the rate of change of a quantity at a given instant using differentiation.
Advanced (L2)	Given a displacement function, find velocity and acceleration using differentiation.
Challenge (L3)	Solve an unfamiliar multi-step modelling problem combining differentiation and integration in a real-life or kinematic context.
Visual Priority	Medium
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Rates of change and introductory kinematics using differentiation/integration
Question Bank Boundary — Should NOT Test	Differential equations requiring formal solution techniques beyond direct integration

Domain: Mathematical Logic, Proof & Reasoning

1. Rigorous Mathematical Proof — Direct, Contradiction & Induction (Introductory)

Topic Code	AL-LR-01
Domain	Mathematical Logic, Proof & Reasoning
Subtopics	Formal direct proof • Formal proof by contradiction • Introductory proof by mathematical induction
Concept Description	Students construct formal direct proofs, proofs by contradiction, and are introduced to proof by mathematical induction.
Learning Outcomes	Students can construct a formal proof using direct reasoning, contradiction, or an introductory induction argument.
Skills Developed	Proof construction, Rigorous reasoning, Communication
Prerequisites	Formal Mathematical Proof — Direct & by Contradiction (Introductory) — O-Level.
Foundation (L1)	Construct a formal direct proof of an A-Level-appropriate claim.
Advanced (L2)	Construct a formal proof by contradiction of a stated claim.
Challenge (L3)	Construct an introductory proof by mathematical induction for a simple summation formula.

Visual Priority	Low
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Direct proof, contradiction, and introductory induction for accessible A-Level claims
Question Bank Boundary — Should NOT Test	Induction proofs requiring advanced strong induction or well-ordering formalism

2. Advanced Counterexamples & Logical Argument

Topic Code	AL-LR-02
Domain	Mathematical Logic, Proof & Reasoning
Subtopics	Constructing counterexamples to advanced claims • Identifying flaws in complex arguments • Rigorous logical structure
Concept Description	Students construct counterexamples to advanced mathematical claims and identify flaws in complex logical arguments.
Learning Outcomes	Students can construct a counterexample to an advanced claim and identify a flaw in a complex given argument.
Skills Developed	Logical reasoning, Critical thinking, Justification
Prerequisites	Rigorous Mathematical Proof — Direct, Contradiction & Induction (Introductory) (this track).
Foundation (L1)	Test an advanced claim using a specific example to check plausibility.
Advanced (L2)	Construct a counterexample that disproves an advanced A-Level-level claim.
Challenge (L3)	Identify and explain a subtle flaw in a complex, multi-step given mathematical argument.
Visual Priority	Low
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Counterexample construction and flaw identification at A-Level standard
Question Bank Boundary — Should NOT Test	Formal metamathematical reasoning about proof systems themselves

3. Critique & Evaluation of Mathematical Arguments

Topic Code	AL-LR-03
Domain	Mathematical Logic, Proof & Reasoning
Subtopics	Comparing two valid solution methods • Evaluating efficiency and elegance • Communicating a reasoned critique
Concept Description	Students compare and critique different valid mathematical arguments or solution methods, evaluating efficiency and rigor.
Learning Outcomes	Students can compare two valid solution methods for the same problem and critique their efficiency and rigor.
Skills Developed	Critical thinking, Communication, Mathematical judgement
Prerequisites	Advanced Counterexamples & Logical Argument (this track).
Foundation (L1)	State one strength or weakness of a given solution method.

Advanced (L2)	Compare two given solution methods and identify which is more efficient, with justification.
Challenge (L3)	Construct a full critique of an unfamiliar mathematical argument, identifying both strengths and any gaps in rigor.
Visual Priority	Low
Recommended Question Types	Proof/reasoning question, Standard MCQ
Question Bank Boundary — Should Test	Critique and evaluation of mathematical arguments and methods at A-Level standard
Question Bank Boundary — Should NOT Test	Formal peer-review-style critique requiring publication-standard mathematical writing

Domain: Problem Solving & Mathematical Modelling

1. Advanced Mathematical Modelling

Topic Code	AL-PS-01
Domain	Problem Solving & Mathematical Modelling
Subtopics	Building models across several A-Level domains • Evaluating and refining a model • Communicating a complete modelling cycle
Concept Description	Students build, evaluate and refine mathematical models of complex real-life situations, communicating the complete modelling cycle.
Learning Outcomes	Students can build, evaluate and refine a mathematical model of a complex real-life situation, communicating each stage clearly.
Skills Developed	Mathematical modelling, Critical thinking, Communication
Prerequisites	Broad A-Level topic base including calculus, functions and statistics.
Foundation (L1)	Build a simple model of a described situation using one A-Level domain.
Advanced (L2)	Build a model combining two A-Level domains (e.g. functions and calculus) and evaluate its fit.
Challenge (L3)	Complete a full modelling cycle for an unfamiliar complex situation, including refining the model based on identified limitations.
Visual Priority	Medium
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Advanced modelling using any combination of A-Level domains
Question Bank Boundary — Should NOT Test	Modelling requiring differential equations beyond direct integration

2. Optimization Problems — Advanced

Topic Code	AL-PS-02
Domain	Problem Solving & Mathematical Modelling
Subtopics	Multi-variable optimization reduced to one variable • Constrained optimization • Real-life advanced optimization contexts
Concept Description	Students solve advanced optimization problems, reducing multi-variable scenarios to a single variable using given constraints.

Learning Outcomes	Students can reduce a constrained multi-variable optimization problem to a single variable and solve it using calculus.
Skills Developed	Mathematical modelling, Differentiation, Strategic thinking
Prerequisites	Increasing/Decreasing Functions & Optimization (this track).
Foundation (L1)	Use a given constraint to express one variable in terms of another in an optimization scenario.
Advanced (L2)	Solve a constrained optimization problem after reducing it to a single variable.
Challenge (L3)	Solve an unfamiliar advanced optimization problem requiring careful setup, constraint substitution, and interpretation of the result.
Visual Priority	Medium
Recommended Question Types	Word problem, Multi-step problem
Question Bank Boundary — Should Test	Constrained optimization problems solvable using single-variable calculus
Question Bank Boundary — Should NOT Test	Optimization requiring Lagrange multipliers or multivariable calculus

3. Non-Routine Advanced Problem Solving

Topic Code	AL-PS-03
Domain	Problem Solving & Mathematical Modelling
Subtopics	Genuinely unfamiliar competition-style problems • Strategic approach selection across domains • Elegant and efficient solution construction
Concept Description	Students apply strategic, flexible thinking to genuinely unfamiliar, advanced competition-style problems spanning multiple A-Level domains.
Learning Outcomes	Students can approach an unfamiliar, advanced problem strategically, selecting and combining methods from across domains.
Skills Developed	Non-routine problem solving, Strategic thinking, Perseverance
Prerequisites	Broad A-Level topic base across all domains.
Foundation (L1)	Solve a non-routine problem with a guided first step, drawing on one A-Level domain.
Advanced (L2)	Solve a non-routine problem combining two or three A-Level domains.
Challenge (L3)	Solve a genuinely unfamiliar, multi-domain competition-style problem requiring an elegant or efficient solution.
Visual Priority	Medium
Recommended Question Types	Standard MCQ, Logical reasoning, Word problem
Question Bank Boundary — Should Test	Non-routine problems built from A-Level concepts only
Question Bank Boundary — Should NOT Test	Problems requiring university-level mathematics beyond this curriculum's scope

11. Class 9 → Class 10 → O-Level → A-Level Progression Map

This spiral progression map shows, for every domain, how each track builds on the previous one. Vectors, Matrices and Calculus are introduced only where the track's academic focus requires them — Matrices and Calculus appear exclusively in A-Level, and Vectors begin only in Class 10.

Domain	Class 9 Foundation	Class 10 Development	O-Level Advanced	A-Level Advanced Maths
Number Systems & Number Theory	Real numbers, surds, indices; proof-like number reasoning.	Advanced surds/indices; Diophantine-style problems.	Sets; advanced surd/index manipulation; modular reasoning.	Rigorous proof-based number theory; enrichment prime/Diophantine puzzles.
Algebra	Expansion, factorization, identities, simultaneous & quadratic equations.	Advanced identities, algebraic fractions, discriminant, quadratic inequalities.	Cube identities, partial fractions, polynomial division, factor/remainder theorem.	Full partial fractions, binomial expansion, parametric relationships, advanced manipulation.
Exponentials & Logarithms	Exponential expressions and growth (introductory).	Exponential equations; introduction to logarithms.	Advanced logarithm laws; combined exponential/logarithmic equations.	Exponential/logarithmic function graphs and modelling; growth/decay applications.
Functions	Function notation, domain/range; linear/quadratic graphs.	Composite functions; introductory inverse functions; translations/reflections.	Advanced domain/range; polynomial and rational function graphs.	Rigorous composite/inverse proofs; combined transformations; asymptotic behaviour; modelling.
Equations & Inequalities	Linear inequalities; quadratic word problems.	Rational and radical equations (introductory).	Higher-degree polynomial equations; graphical inequality regions.	Advanced multi-technique equations; advanced inequality systems.
Sequences & Series	Arithmetic nth term/series; geometric sequences (introductory).	Arithmetic and geometric series sum formulas; applications.	Sigma notation (introductory); combined sequence/series applications.	Advanced series applications; formal sigma notation; convergence; recursive sequences.
Euclidean Geometry	Congruence/similarity, Pythagoras, chords, arcs, tangents, polygon proofs.	Cyclic quadrilaterals, tangent-chord angle, advanced similarity, multi-step proof.	Full circle theorems, formal congruence/similarity proof, 3D geometry (introductory).	Rigorous multi-theorem proofs; comprehensive circle theorem application; advanced 3D reasoning.
Coordinate Geometry	Distance, midpoint, gradient; equation of a line; parallel/perpendicular.	Equation of a circle (introductory); coordinate proofs; loci.	Advanced circle equations; tangents via coordinates; perpendicular bisector loci.	Circles through three points; advanced loci; line-curve intersections; coordinate transformations.
Mensuration	Prisms, pyramids, cylinders, cones, spheres; similar figure scale factors.	Advanced composite solids; arc length and sector area.	Advanced composite solids; mensuration in coordinate contexts.	Advanced 3D composite reasoning combined with trigonometry and vectors.
Trigonometry	Right-triangle trigonometry; elevation/depression; bearings.	Sine rule, cosine rule, triangle area formula, trigonometric graphs (introductory).	Fundamental identities; trigonometric equations; full sine/cosine/tangent graphs; 3D trigonometry.	Compound/double angle identities; general solutions; radians; advanced combined applications.
Statistics	Grouped data, histograms, cumulative frequency & quartiles (tables).	Cumulative frequency curves; standard deviation (introductory); comparing distributions.	Advanced standard deviation; correlation, scatter diagrams, regression concepts.	Effect of transformations on variance; discrete distributions; binomial distribution; model evaluation.
Probability	Tree diagrams; mutually exclusive & independent events.	Conditional probability (introductory); Venn diagrams and set-based probability.	Formal conditional probability; independence testing; expected value (introductory).	Expected value & variance of a distribution; advanced conditional probability & independence.
Combinatorics & Counting	Fundamental counting principle.	Permutations and combinations (introductory).	Advanced permutations/combinations with restrictions; combinatorial problem solving.	Complex combined restrictions; pigeonhole-style combinatorial reasoning.

Domain	Class 9 Foundation	Class 10 Development	O-Level Advanced	A-Level Advanced Maths
Vectors	(Not yet introduced — begins in Class 10.)	Vector notation, magnitude, direction; addition and position vectors.	Ratio division of segments; vector proofs of collinearity/parallelism.	Advanced vector proofs; 3D vectors; introductory mechanics-style applications.
Matrices	(Not part of Class 9–10 syllabus.)	(Not part of Class 9–10 syllabus.)	(Not part of the O-Level syllabus.)	Matrix operations; determinants and inverse matrices; solving systems using matrices.
Calculus	(Not part of Class 9–10 syllabus.)	(Not part of Class 9–10 syllabus.)	(Not part of the O-Level syllabus.)	Differentiation (power/product/quotient/chain rules); integration; optimization; applications.
Mathematical Logic, Proof & Reasoning	Always/sometimes/never; introductory algebraic/geometric proof.	Direct & indirect reasoning; divisibility/algebraic proof.	Formal proof (direct & introductory contradiction); advanced logical/algebraic reasoning.	Rigorous proof (direct, contradiction, introductory induction); advanced counterexamples; critique.
Problem Solving & Mathematical Modelling	Multi-step, multi-domain problems; introductory modelling.	Multi-step analytical problems; modelling growth and rates.	Advanced multi-step problems; introductory optimization modelling.	Advanced modelling; advanced optimization; genuinely non-routine multi-domain problems.

12. MCQ Assessment Blueprint

The following domain-weighting tables give future question writers a recommended percentage distribution for each track. Algebra and Geometry carry substantial weight throughout, reflecting their centrality to secondary mathematics. Calculus dominates the A-Level distribution (22%) as the track's defining advanced content, while Matrices and Vectors appear only from Class 10 (Vectors) or exclusively at A-Level (Matrices), consistent with the curriculum boundary in Section 10.

Class 9 — Domain Distribution

Mathematical Domain	% of Question Bank
Number Systems & Number Theory	6%
Algebra	16%
Exponentials & Logarithms	2%
Functions	5%
Equations & Inequalities	5%
Sequences & Series	4%
Euclidean Geometry	14%
Coordinate Geometry	7%
Mensuration	7%
Trigonometry	7%
Statistics	7%
Probability	5%
Combinatorics & Counting	2%
Vectors	0%
Matrices	0%

Mathematical Domain	% of Question Bank
Calculus	0%
Mathematical Logic, Proof & Reasoning	5%
Problem Solving & Mathematical Modelling	8%
Total	**100%**

Class 10 — Domain Distribution

Mathematical Domain	% of Question Bank
Number Systems & Number Theory	5%
Algebra	14%
Exponentials & Logarithms	4%
Functions	7%
Equations & Inequalities	4%
Sequences & Series	6%
Euclidean Geometry	11%
Coordinate Geometry	7%
Mensuration	4%
Trigonometry	9%
Statistics	7%
Probability	4%
Combinatorics & Counting	4%
Vectors	4%
Matrices	0%
Calculus	0%
Mathematical Logic, Proof & Reasoning	4%
Problem Solving & Mathematical Modelling	6%
Total	**100%**

O-Level — Domain Distribution

Mathematical Domain	% of Question Bank
Number Systems & Number Theory	5%
Algebra	12%
Exponentials & Logarithms	4%
Functions	8%
Equations & Inequalities	6%
Sequences & Series	4%
Euclidean Geometry	10%
Coordinate Geometry	8%
Mensuration	4%

Mathematical Domain	% of Question Bank
Trigonometry	10%
Statistics	8%
Probability	6%
Combinatorics & Counting	6%
Vectors	4%
Matrices	0%
Calculus	0%
Mathematical Logic, Proof & Reasoning	3%
Problem Solving & Mathematical Modelling	2%
Total	**100%**

A-Level — Domain Distribution

Mathematical Domain	% of Question Bank
Number Systems & Number Theory	2%
Algebra	8%
Exponentials & Logarithms	5%
Functions	7%
Equations & Inequalities	3%
Sequences & Series	5%
Euclidean Geometry	4%
Coordinate Geometry	5%
Mensuration	1%
Trigonometry	7%
Statistics	6%
Probability	3%
Combinatorics & Counting	2%
Vectors	4%
Matrices	4%
Calculus	22%
Mathematical Logic, Proof & Reasoning	5%
Problem Solving & Mathematical Modelling	6%
Total	**99%**

13. Difficulty Distribution

Reflecting increasing mathematical maturity across the four tracks, the proportion of Challenge-level items rises steadily from Class 9 through A-Level, with the Challenge component always emphasizing mathematical reasoning and non-routine problem solving rather than additional syllabus content.

Class 9

Difficulty Level	% of Question Bank
Level 1 — Foundation	30%
Level 2 — Advanced	42%
Level 3 — Challenge	28%

Class 10

Difficulty Level	% of Question Bank
Level 1 — Foundation	24%
Level 2 — Advanced	42%
Level 3 — Challenge	34%

O-Level

Difficulty Level	% of Question Bank
Level 1 — Foundation	18%
Level 2 — Advanced	42%
Level 3 — Challenge	40%

A-Level

Difficulty Level	% of Question Bank
Level 1 — Foundation	15%
Level 2 — Advanced	40%
Level 3 — Challenge	45%

14. Future Question Bank Tagging System

Every Markhor Junior Aspirant Level MCQ should be tagged using the following standardised code, consistent with the Beginner, Learner, Elementary and Pioneer Level systems and scalable to future assessments:

TRACK – DOMAIN – DIFFICULTY – TYPE – SEQUENCE

Example: AL-CL-C-MP-014 → A-Level, Calculus, Challenge, Multi-step problem, item 14.

Track Codes

Code	Meaning
C9	Aspirant Level — Class 9
C10	Aspirant Level — Class 10
OL	Aspirant Level — O-Level
AL	Aspirant Level — A-Level

Domain Codes

Code	Meaning
NT	Number Systems & Number Theory
AL	Algebra
EL	Exponentials & Logarithms
FN	Functions
EQ	Equations & Inequalities
SQ	Sequences & Series
GE	Euclidean Geometry
CG	Coordinate Geometry
MN	Mensuration
TR	Trigonometry
ST	Statistics
PR	Probability
CO	Combinatorics & Counting
VE	Vectors
MA	Matrices
CL	Calculus
LR	Mathematical Logic, Proof & Reasoning
PS	Problem Solving & Mathematical Modelling

Difficulty Codes

Code	Meaning
F	Foundation (Level 1)
A	Advanced (Level 2)
C	Challenge (Level 3)

Question Type Codes

Code	Meaning
MCQ	Standard multiple-choice question
AMCQ	Advanced multiple-choice question
NRQ	Numerical reasoning MCQ
ALQ	Algebraic MCQ
GQ	Graph-based MCQ
GEQ	Geometry MCQ
DP	Data interpretation
PRQ	Probability question
PJQ	Proof / reasoning (justification) question
ERR	Error-detection question
SEV	Statement evaluation
MCP	Multi-condition problem
MP	Multi-step problem
OPT	Optimization problem
NRC	Non-routine challenge
WP	Word / real-life problem
PMCQ	Picture-based MCQ
LR	Logical reasoning question

15. Assessment Alignment

This curriculum is structured to directly support every future Markhor Junior assessment product across all four Aspirant Level tracks:

- Practice Test — reinforces individual topics and targeted skill practice, drawing mainly from Foundation and Advanced level items within each track.
- Mock Test — provides mixed-topic, timed examination preparation across all eighteen domains, following each track's MCQ Assessment Blueprint distribution.
- Past Paper — offers contest-style revision and benchmarking, balancing all three difficulty levels as previously used in official Markhor Junior papers.
- Contest Paper — delivers a balanced evaluation of mathematical knowledge, reasoning, strategy and non-routine problem solving, weighted according to each track's official domain and difficulty distributions in Sections 12 and 13.

16. Master Syllabus Table

A single reference table for teachers, curriculum managers, question writers and AI question-generation systems, for each of the four tracks. Full topic detail (subtopics, concept description, skills, prerequisites, should/should-not boundaries) is provided in the Detailed Topic-by-Topic Curriculum sections above; this table gives a compact, scannable overview.

Class 9

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
C9-NT-01	NT	Real Number System & Surds (Introductory)	Simplify a surd such as √50 to its simplest form.	Add or subtract two like surds after simplification.	Determine whether a given expression involving surds is rational or irrational, with justification.	Low
C9-NT-02	NT	Indices & Laws of Indices	Apply a single law of indices to simplify an expression.	Simplify an expression combining two or more index laws, including negative indices.	Solve an equation where the unknown appears as an exponent, using index law reasoning.	Low
C9-NT-03	NT	Number Theory Reasoning & Proof-Like Problems	Test a number-property claim using several numerical examples.	Represent even/odd numbers algebraically (e.g. 2n, 2n+1) to justify a claim.	Construct a complete proof-like argument for a divisibility or parity claim using algebraic representation.	Low
C9-AL-04	AL	Algebraic Expansion & Factorization	Expand two binomials, e.g. (x+2)(x+5).	Factorize a quadratic trinomial with a leading coefficient of 1.	Factorize a quadratic trinomial with a leading coefficient greater than 1, or by grouping four terms.	Low
C9-AL-05	AL	Algebraic Identities	Expand $(a+b)^2$ or $(a-b)^2$ using the identity.	Factorize an expression using the difference of two squares.	Use an identity to efficiently evaluate a numerical expression without direct calculation (e.g. $102^2 - 98^2$).	Low
C9-AL-06	AL	Algebraic Fractions (Introductory)	Simplify an algebraic fraction by cancelling a common factor.	Multiply or divide two algebraic fractions.	Add or subtract two algebraic fractions with different but related denominators.	Low
C9-AL-07	AL	Simultaneous Linear Equations	Solve a simple pair of simultaneous equations by substitution.	Solve a pair of simultaneous equations by elimination, including scaling one equation first.	Set up and solve simultaneous equations from an unfamiliar word problem.	Low
C9-AL-08	AL	Quadratic Equations — Factorization Method	Solve a quadratic equation that factorizes directly.	Solve a quadratic equation requiring rearrangement into standard form first.	Form a quadratic equation given its two roots and verify by expansion.	Low
C9-AL-09	AL	Quadratic Equations — Formula & Completing the Square	Solve a quadratic equation using the quadratic formula.	Complete the square for a quadratic expression and use it to solve the equation.	Choose the most efficient method (factorization, formula, or completing the square) for an unfamiliar quadratic.	Low
C9-EL-10	EL	Introduction to Exponential Expressions & Growth	Evaluate a simple exponential expression for a given value.	Compare the growth of a linear and an exponential model over several steps.	Solve a real-life problem involving repeated exponential growth or decay (e.g. population, depreciation).	Medium
C9-FN-11	FN	Function Notation, Domain & Range (Introductory)	Evaluate f(x) for a given value of x.	State the domain and range of a simple linear or quadratic function.	Determine the domain of a function involving a simple restriction (e.g. a	Medium

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
					denominator that cannot be zero).	
C9-FN-12	FN	Linear & Quadratic Functions — Graphs	Sketch a linear graph from its equation.	Sketch a quadratic graph, identifying the vertex and axis of symmetry.	Determine the equation of a quadratic graph from its key features (roots and one other point).	High
C9-EQ-13	EQ	Linear Inequalities	Solve a one-step linear inequality.	Solve a compound inequality (e.g. $-3 < 2x+1 \leq 7$).	Solve a word problem requiring the setup of a linear inequality with a real-life constraint.	Medium
C9-EQ-14	EQ	Quadratic Equations — Word Problems	Set up and solve a simple quadratic word problem (e.g. area of a rectangle).	Set up and solve a quadratic word problem requiring rejection of a negative or invalid solution.	Solve a multi-step quadratic word problem with an unfamiliar or layered context.	Medium
C9-SQ-15	SQ	Arithmetic Sequences — nth Term & Series	Find the nth term of an arithmetic sequence using the formula.	Calculate the sum of the first n terms of an arithmetic series.	Solve a problem requiring both the nth term and sum formulas together in an unfamiliar context.	Low
C9-SQ-16	SQ	Geometric Sequences (Introductory)	Identify the common ratio of a geometric sequence.	Find the nth term of a geometric sequence.	Determine whether a given sequence is arithmetic, geometric or neither, and justify the answer.	Low
C9-GE-17	GE	Congruence & Similarity — Advanced Reasoning	Identify a pair of congruent or similar triangles in a simple diagram.	Use similarity to find a missing length in a diagram with overlapping triangles.	Solve a multi-step problem requiring both congruence and similarity reasoning in the same diagram.	High
C9-GE-18	GE	Pythagorean Theorem & Applications	Find the hypotenuse of a right triangle given the two shorter sides.	Find a missing shorter side of a right triangle given the hypotenuse.	Solve a multi-step real-life problem requiring the Pythagorean theorem combined with another skill (e.g. coordinate distance).	High
C9-GE-19	GE	Circle Geometry — Chords & Arcs	Identify a chord, arc and central angle in a circle diagram.	Use the property that equal chords subtend equal arcs to find a missing value.	Use the perpendicular-from-centre-to-chord property in a multi-step problem.	High
C9-GE-20	GE	Circle Geometry — Tangents (Introductory)	Identify a tangent line to a circle and state its key property.	Find a missing angle using the tangent-radius perpendicularity property.	Solve a problem involving two tangents drawn from the same external point.	High
C9-GE-21	GE	Polygon & Angle Proofs	Justify a single angle fact in a polygon diagram.	Combine two angle facts to justify a missing angle in a multi-step diagram.	Construct a full justified argument for an angle in an unfamiliar, multi-step diagram.	High
C9-GE-22	GE	Geometric Proof — Multi-Step Reasoning	State the single property that justifies one step of a given argument.	Complete a partially-given multi-step geometric argument.	Construct an original multi-step geometric argument from a new diagram, communicating each step clearly.	Medium
C9-CG-23	CG	Distance, Midpoint & Gradient	Calculate the distance between two points using the distance formula.	Calculate the midpoint and gradient of a segment given its endpoints.	Solve a multi-step problem requiring distance, midpoint and gradient together (e.g. classifying a triangle).	High
C9-CG-24	CG	Equation of a Straight Line	Write the equation of a line given its gradient and y-intercept.	Find the equation of a line given its gradient and one point on the line.	Find the equation of a line given two points, then use it to solve a related problem.	High

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
C9-CG-25	CG	Parallel & Perpendicular Lines	Determine whether two given lines are parallel.	Find the equation of a line parallel or perpendicular to a given line, through a given point.	Use parallel/perpendicular conditions in a simple coordinate proof (e.g. showing a triangle is right-angled).	High
C9-MN-26	MN	Surface Area & Volume of Prisms and Pyramids	Calculate the volume of a triangular prism given its dimensions.	Calculate the surface area of a prism using its net.	Calculate the volume of a pyramid and solve a related real-life problem.	High
C9-MN-27	MN	Surface Area & Volume of Cylinders, Cones & Spheres	Calculate the volume of a cylinder given its radius and height.	Calculate the surface area of a cone given its radius and slant height.	Solve a real-life problem involving the volume or surface area of a composite solid including a curved solid.	High
C9-MN-28	MN	Similar Figures — Area & Volume Scale Factors	Given the linear scale factor, find the area scale factor between two similar figures.	Given the area of one similar figure, find the area of another using the scale factor.	Solve a multi-step real-life problem involving volume scale factor between similar solids.	High
C9-TR-29	TR	Right-Triangle Trigonometry — Sine, Cosine, Tangent	Find a missing side using sine, cosine or tangent, given an angle and one side.	Find a missing angle using an inverse trigonometric ratio.	Solve a multi-step right-triangle problem requiring more than one trigonometric ratio or the Pythagorean theorem together.	High
C9-TR-30	TR	Angles of Elevation & Depression	Find a missing height or distance given an angle of elevation and a known distance.	Find a missing angle of elevation or depression given the relevant sides.	Solve a multi-step problem involving two angles of elevation/depression observed from different points.	High
C9-TR-31	TR	Bearings	State the three-figure bearing shown in a simple diagram.	Find a missing distance or angle in a bearing problem using right-triangle trigonometry.	Solve a multi-step bearing problem involving two or more legs of a journey.	High
C9-ST-32	ST	Grouped Data & Histograms	Complete a grouped frequency table from raw data.	Construct a histogram with equal class widths from a grouped frequency table.	Interpret a histogram to answer a question requiring combining information from more than one class interval.	High
C9-ST-33	ST	Mean, Median & Mode for Grouped Data	Identify the modal class of a grouped frequency table.	Estimate the mean of grouped data using midpoints.	Compare the estimated mean of two grouped data sets and justify which is more reliable.	Medium
C9-ST-34	ST	Cumulative Frequency & Quartiles	Construct a cumulative frequency table from a grouped frequency table.	Estimate the median from a cumulative frequency table.	Estimate the interquartile range and use it to compare two data sets.	High
C9-PR-35	PR	Tree Diagrams & Combined Events	Construct a tree diagram for a two-stage experiment with replacement.	Construct a tree diagram for a two-stage experiment without replacement.	Use a tree diagram to solve a multi-stage probability problem requiring several branches to be combined.	High
C9-PR-36	PR	Mutually Exclusive & Independent Events	Apply the addition rule to find the probability of one of two mutually exclusive events.	Apply the multiplication rule to find the probability of two independent events both occurring.	Solve a problem requiring the student to first determine whether events are mutually exclusive, independent, or neither.	Medium
C9-CO-37	CO	Fundamental Counting Principle & Organized Counting	Apply the counting principle to a two-stage scenario.	Apply the counting principle to a three- or four-stage scenario.	Apply the counting principle to a scenario with a restriction (e.g. a specific item	Medium

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
					must/must not be included).	
C9-LR-38	LR	Always, Sometimes or Never — Secondary Level	Test a statement involving quadratics or geometry using one or two examples.	Find a counterexample that disproves a claim involving Class 9 algebra or geometry.	Justify why a Class 9-level statement is always true using a general algebraic or geometric argument.	Low
C9-LR-39	LR	Algebraic & Geometric Proof (Introductory)	Complete a partially-given simple proof.	Construct a short algebraic proof of a number claim (e.g. the sum of two consecutive integers).	Construct a short geometric proof combining two or more known properties.	Low
C9-PS-40	PS	Multi-Step Problem Solving Across Domains	Solve a two-domain problem with familiar numbers.	Solve a three-step problem combining two or three domains.	Solve a problem combining three or more domains with an unfamiliar context.	Medium
C9-PS-41	PS	Mathematical Modelling — Real-World Applications	Identify the key variables in a described real-world situation.	Build a simple equation or formula modelling a described situation.	Evaluate the limitations or assumptions of a given simple model and suggest an improvement.	Medium
C9-PS-42	PS	Non-Routine Reasoning Problems	Solve a non-routine problem with a guided first step.	Solve a non-routine problem combining two or three known Class 9 concepts.	Solve a genuinely unfamiliar, multi-condition problem requiring an elegant or efficient solution.	Medium

Class 10

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
C10-NT-01	NT	Surds — Simplification & Rationalizing	Multiply two surds and simplify the result.	Rationalize a denominator of the form a/√b.	Rationalize a denominator involving a binomial surd expression (e.g. a/(√b + c)).	Low
C10-NT-02	NT	Indices — Fractional & Negative Indices	Evaluate an expression with a simple fractional index (e.g. 8^(1/3)).	Simplify an expression combining fractional and negative indices.	Solve an equation where the unknown appears as a fractional or negative exponent.	Low
C10-NT-03	NT	Number Theory — Diophantine-Style Problems	Find integer solutions to a simple linear equation with a stated range constraint.	Find all integer pairs satisfying a simple two-variable equation within given bounds.	Solve a competition-style Diophantine-style puzzle requiring systematic elimination of cases.	Low
C10-AL-04	AL	Algebraic Identities — Advanced Expansion/Factorization	Expand a product of three simple linear factors.	Factorize an expression using a combination of common factor and difference-of-squares identities.	Factorize or simplify an expression using an introductory sum/difference of cubes identity.	Low
C10-AL-05	AL	Algebraic Fractions — Operations & Simplification	Add two algebraic fractions with unlike but simple denominators.	Simplify a complex algebraic fraction involving factorization first.	Solve an equation involving two or more algebraic fractions.	Low
C10-AL-06	AL	Simultaneous Equations — Linear & Quadratic	Solve a simple linear-quadratic system by direct substitution.	Solve a linear-quadratic system requiring rearrangement before substitution.	Interpret geometrically (using a sketch) why a linear-quadratic system has zero, one, or two solutions.	High
C10-AL-07	AL	Quadratic Equations — Discriminant & Nature of Roots	Calculate the discriminant of a given quadratic equation.	Use the discriminant to determine whether a quadratic has two, one, or no real roots.	Find the range of values of a parameter for which a quadratic has real roots, using the discriminant.	Low
C10-AL-08	AL	Quadratic Inequalities	Solve a quadratic inequality that factorizes directly, using a sketch of the parabola.	Solve a quadratic inequality requiring the quadratic formula to find critical values first.	Solve a real-life problem requiring the setup and solving of a quadratic inequality.	High
C10-AL-09	AL	Absolute Value Equations & Inequalities (Introductory)	Solve a simple absolute value equation, e.g. |x − 2| = 5.	Solve a simple absolute value inequality, e.g. |x + 1| < 4.	Solve a real-life problem interpreting absolute value as a distance or tolerance constraint.	Medium
C10-EL-10	EL	Exponential Equations	Solve an exponential equation where both sides can be written with the same base.	Solve an exponential equation requiring a substitution (e.g. letting y = 2^x).	Solve a real-life exponential growth/decay problem requiring the equation to be set up and solved.	Medium
C10-EL-11	EL	Introduction to Logarithms & Laws of Logarithms	Convert a simple exponential statement into logarithmic form and vice versa.	Apply a single law of logarithms to simplify a logarithmic expression.	Solve a simple logarithmic equation using the laws of logarithms.	Low
C10-FN-12	FN	Composite Functions	Evaluate fg(x) for a given numerical value of x.	Find the algebraic expression for fg(x) given f(x) and g(x).	Solve an equation involving a composite function, e.g. fg(x) = a given value.	Low
C10-FN-13	FN	Inverse Functions (Introductory)	Find the inverse of a simple linear function.	Verify that two functions are inverses of each other using composition.	Find the inverse of a function involving a simple square or square root, stating any domain restriction needed.	High

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
C10-FN-14	FN	Graph Transformations — Translations & Reflections	Sketch f(x) + a for a simple function f and constant a.	Sketch f(x + a) or −f(x) for a simple function f.	Describe, in function notation, the single or combined transformation that maps one given graph to another.	High
C10-EQ-15	EQ	Rational Equations (Introductory)	Solve a rational equation with a single fraction term.	Solve a rational equation with two fraction terms, clearing denominators.	Solve a rational equation that produces an extraneous solution, and identify and reject it.	Low
C10-EQ-16	EQ	Radical Equations (Introductory)	Solve a radical equation with the square root isolated on one side.	Solve a radical equation requiring rearrangement before squaring.	Solve a radical equation that produces an extraneous solution, and identify and reject it by checking.	Low
C10-SQ-17	SQ	Arithmetic Series — Sum Formula	Calculate the sum of the first n terms given the first term and common difference.	Find the number of terms needed to reach a given sum.	Solve a real-life word problem modelled by an arithmetic series (e.g. stacking, seating, savings).	Low
C10-SQ-18	SQ	Geometric Series — Sum Formula	Calculate the sum of the first n terms of a geometric series.	Calculate the sum to infinity of a geometric series with |r| < 1.	Solve a real-life problem modelled by a geometric series (e.g. compound scenarios, repeated halving).	Low
C10-SQ-19	SQ	Sequence & Series Applications	Identify whether a real-life scenario is best modelled by an arithmetic or geometric sequence.	Solve a two-step problem combining sequence identification with a sum calculation.	Solve an unfamiliar multi-step problem combining both arithmetic and geometric reasoning.	Medium
C10-GE-20	GE	Circle Geometry — Cyclic Quadrilaterals	Find a missing angle using the opposite-angles-sum-to-180° property.	Find a missing angle using the exterior angle property of a cyclic quadrilateral.	Solve a multi-step diagram combining cyclic quadrilateral properties with other circle facts.	High
C10-GE-21	GE	Circle Geometry — Tangent-Chord Angle	Identify the angle described by the tangent-chord property in a labelled diagram.	Find a missing angle using the tangent-chord angle property directly.	Solve a multi-step diagram combining the tangent-chord property with cyclic quadrilateral or other circle facts.	High
C10-GE-22	GE	Advanced Similarity & Area Ratios	Find the scale factor between two similar triangles in a moderately complex figure.	Find the area ratio between two similar triangles given their scale factor.	Solve a multi-step problem requiring similarity reasoning combined with area or length calculation.	High
C10-GE-23	GE	Multi-Step Geometric Proof	Complete a partially-given multi-step proof involving circle or triangle facts.	Construct a proof combining two different types of geometric fact (e.g. circle and triangle).	Construct an original multi-step proof for an unfamiliar diagram, combining three or more properties.	High
C10-GE-24	GE	Constructions & Loci (Introductory)	Construct the perpendicular bisector of a line segment.	Describe the locus of points equidistant from two given points or lines.	Construct a locus satisfying two combined conditions (e.g. equidistant from a point and a line).	High
C10-CG-25	CG	Equation of a Circle (Introductory)	State the centre and radius of a circle given in standard form.	Determine whether a given point lies on, inside, or outside a circle.	Find the equation of a circle given its centre and a point on its circumference.	High
C10-CG-26	CG	Coordinate Geometry Proofs	Use the distance formula to show that two given sides of a triangle are equal.	Use gradient to show that a triangle is right-angled.	Construct a complete coordinate proof combining distance, midpoint and gradient reasoning for an unfamiliar shape.	High

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
C10-CG-27	CG	Geometric Loci on the Coordinate Plane	Find the equation of the locus of points equidistant from two given points (the perpendicular bisector).	Find the equation of the locus of points a fixed distance from a given point (a circle).	Solve a multi-step problem finding the intersection of two loci.	High
C10-MN-28	MN	Composite Solids — Advanced Problems	Calculate the volume of a composite solid formed from a cylinder and a cone.	Calculate the surface area of a composite solid, being careful to exclude internal joined faces.	Find a missing dimension of a composite solid given its total volume or surface area.	High
C10-MN-29	MN	Arc Length & Sector Area	Calculate the arc length of a sector given its angle and the circle's radius.	Calculate the area of a sector given its angle and the circle's radius.	Solve a composite problem combining sector area or arc length with another shape.	High
C10-TR-30	TR	Sine Rule	Find a missing side using the sine rule given two angles and one side.	Find a missing angle using the sine rule given two sides and one angle.	Recognise and resolve the ambiguous case of the sine rule, finding both possible solutions.	High
C10-TR-31	TR	Cosine Rule	Find a missing side using the cosine rule given two sides and the included angle.	Find a missing angle using the cosine rule given three sides.	Solve a multi-step problem requiring the student to choose between the sine and cosine rule.	High
C10-TR-32	TR	Area of a Triangle Using Trigonometry	Calculate the area of a triangle given two sides and the included angle.	Find a missing angle or side given the area of a triangle and other information.	Solve a multi-step problem combining the area formula with the sine or cosine rule.	Medium
C10-TR-33	TR	Trigonometric Graphs (Introductory)	Identify the amplitude and period of a basic sine or cosine graph.	Sketch the graph of sine or cosine over the full 0°–360° range, labelling key points.	Read multiple solutions from a trigonometric graph for a given equation (e.g. sin x = 0.5).	High
C10-ST-34	ST	Cumulative Frequency Curves & Median Estimation	Plot a cumulative frequency curve from a given table.	Use a cumulative frequency curve to estimate the median.	Use a cumulative frequency curve to estimate the interquartile range and compare two data sets.	High
C10-ST-35	ST	Variance & Standard Deviation (Introductory)	Calculate the mean and deviations from the mean for a small data set.	Calculate the variance and standard deviation of a small ungrouped data set.	Compare the standard deviations of two data sets and interpret what this reveals about their spread.	Low
C10-ST-36	ST	Comparing Distributions	Compare two distributions using their means.	Compare two distributions using both a measure of centre and a measure of spread.	Justify a conclusion about two distributions using cumulative frequency, standard deviation and context together.	Medium
C10-PR-37	PR	Conditional Probability (Introductory)	Calculate a conditional probability directly from a two-way table.	Calculate a conditional probability from a tree diagram involving dependent events.	Solve a real-life problem requiring conditional probability reasoning across multiple stages.	High
C10-PR-38	PR	Venn Diagrams & Set-Based Probability	Complete a two-set Venn diagram from given frequency information.	Use set notation (union, intersection, complement) to describe and calculate a probability.	Construct and use a three-set Venn diagram to solve a multi-step probability problem.	High
C10-CO-39	CO	Permutations (Introductory)	Calculate the number of ways to arrange all of a small set of distinct items.	Calculate the number of permutations of r items chosen from n distinct items.	Solve a permutation problem with a simple restriction (e.g. two specific items must be together).	Medium
C10-CO-40	CO	Combinations (Introductory)	Calculate the number of ways to choose r	Determine whether a given problem	Solve a combination problem with a simple	Medium

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
			items from n where order does not matter.	requires permutations or combinations, and solve accordingly.	restriction (e.g. a specific item must/must not be selected).	
C10-VE-41	VE	Vector Notation, Magnitude & Direction	Write a vector connecting two given points in column form.	Calculate the magnitude of a given vector.	Find a vector of a given magnitude in the same direction as a given vector.	High
C10-VE-42	VE	Vector Addition & Position Vectors	Add or subtract two given vectors.	Find the vector between two points given their position vectors.	Solve a simple geometric problem using vector addition and position vectors (e.g. finding a midpoint vector).	High
C10-LR-43	LR	Direct & Indirect Reasoning	Construct a direct proof of a simple algebraic claim.	Describe, in outline, why assuming the opposite of a claim leads to a contradiction (without full formal rigor).	Choose between a direct and an indirect approach for a given claim and justify the choice.	Low
C10-LR-44	LR	Divisibility & Algebraic Proof	Represent a class of integers algebraically (e.g. multiples of 3 as 3n).	Prove that a simple algebraic expression is always divisible by a given number.	Prove a multi-step divisibility claim combining more than one algebraic representation.	Low
C10-PS-45	PS	Multi-Step Analytical Problem Solving	Solve a two-domain analytical problem with familiar numbers.	Solve a three-step analytical problem combining two or three domains.	Solve an unfamiliar analytical problem combining three or more Class 10 domains.	Medium
C10-PS-46	PS	Mathematical Modelling — Growth & Rates	Identify whether a described situation is best modelled linearly, exponentially, or otherwise.	Build an equation or sequence modelling a described growth or rate situation.	Evaluate the assumptions and limitations of a given growth/rate model and suggest a refinement.	Medium

O-Level

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
OL-NT-01	NT	Sets — Notation & Venn Diagram Operations	Use set notation to describe the union or intersection of two sets.	Solve a problem using a two-set Venn diagram with numerical values.	Solve a multi-step problem using a three-set Venn diagram.	High
OL-NT-02	NT	Surds & Indices — Advanced Manipulation	Simplify an expression combining surds and fractional indices.	Solve an equation of the form √(x+a) = b.	Solve an equation involving two surd terms, checking for extraneous solutions.	Low
OL-NT-03	NT	Number Theory — Modular Reasoning (Introductory)	Find the remainder when a number is divided by a given divisor.	Use a repeating remainder pattern to find a remainder for a large exponent or term number.	Solve a competition-style puzzle requiring combined modular and divisibility reasoning.	Low
OL-AL-04	AL	Advanced Factorization — Sum/Difference of Cubes	Recognise a sum or difference of two cubes in an expression.	Factorize an expression using the sum or difference of cubes identity.	Simplify a more complex expression requiring cube identities combined with other factorization techniques.	Low
OL-AL-05	AL	Partial Fractions (Introductory)	Set up the correct partial fraction form for a rational expression with two distinct linear factors.	Find the unknown constants in a partial fraction decomposition.	Decompose a rational expression with three distinct linear factors, verifying by recombining.	Low
OL-AL-06	AL	Polynomial Division	Divide a cubic polynomial by a linear divisor using long division.	Divide a polynomial by a quadratic divisor.	Use polynomial division as part of a multi-step problem involving the remainder or factor theorem.	Low
OL-AL-07	AL	Remainder & Factor Theorem	Use the remainder theorem to find the remainder when a polynomial is divided by a simple linear factor.	Use the factor theorem to determine whether a given linear expression is a factor of a polynomial.	Find an unknown coefficient in a polynomial given that a specific linear expression is a factor.	Low
OL-AL-08	AL	Quadratic Functions — Completing the Square & Vertex Form	Convert a simple quadratic to vertex form by completing the square.	Use vertex form to state the maximum or minimum value of a quadratic function.	Solve a real-life optimization problem by converting a quadratic model to vertex form.	High
OL-AL-09	AL	Simultaneous Equations — Three Variables (Introductory)	Eliminate one variable from two of three given equations.	Solve a complete system of three linear equations in three unknowns.	Set up and solve a three-variable system from an unfamiliar word problem.	Low
OL-EL-10	EL	Laws of Logarithms — Advanced Applications	Apply two laws of logarithms in sequence to simplify an expression.	Use the change of base formula to evaluate a logarithm with an uncommon base.	Simplify a logarithmic expression requiring three or more combined laws.	Low
OL-EL-11	EL	Exponential & Logarithmic Equations — Combined	Solve a simple exponential equation using logarithms when bases do not match.	Solve a logarithmic equation by converting to exponential form.	Solve a real-life problem (e.g. compound growth, half-life) requiring exponential/logarithmic equation solving.	Medium
OL-FN-12	FN	Domain & Range — Advanced Reasoning	Determine the domain of a function with a single denominator restriction.	Determine the domain of a function involving a square root restriction.	Determine the domain and range of a composite function, accounting for restrictions from both component functions.	Medium
OL-FN-13	FN	Composite & Inverse Functions — Advanced	Evaluate a composite of three functions for a given input.	Find the inverse of a function involving a fraction.	Find the inverse of a function requiring a domain restriction to ensure it is one-to-one, and state the restriction.	Medium

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
OL-FN-14	FN	Polynomial Functions — Graphs & Behaviour	Sketch a cubic graph given its roots in factorized form.	Describe the end behaviour of a polynomial graph from its degree and leading coefficient.	Sketch a polynomial graph with a repeated root, showing the correct qualitative behaviour at that root.	High
OL-FN-15	FN	Rational Functions (Introductory)	Identify the domain restriction of a simple rational function.	Sketch a simple rational function graph, showing its vertical asymptote.	Identify both vertical and horizontal asymptotes of a simple rational function and sketch its graph accordingly.	High
OL-EQ-16	EQ	Polynomial Equations — Higher Degree	Solve a cubic equation given one factor.	Find a factor of a cubic equation by testing values, then solve completely.	Solve a quartic equation that factorizes into a product of a quadratic and two linear factors.	Low
OL-EQ-17	EQ	Simultaneous Equations — Graphical & Algebraic Methods	Find the intersection point of two given graphs.	Solve a system both graphically and algebraically and confirm the results agree.	Interpret a real-life situation modelled by two intersecting graphs (e.g. break-even analysis).	High
OL-EQ-18	EQ	Inequalities — Graphical Regions	Shade the region satisfying a single linear inequality.	Shade the region satisfying a system of two or three linear inequalities.	Solve a simple linear programming problem by identifying the optimal point in a feasible region.	High
OL-SQ-19	SQ	Sigma Notation (Introductory)	Evaluate a simple sum given in sigma notation by direct expansion.	Express a given arithmetic or geometric series using sigma notation.	Evaluate a sum in sigma notation using the arithmetic or geometric series formula rather than direct expansion.	Low
OL-SQ-20	SQ	Sequences & Series — Combined Applications	Solve a two-step problem using a single sequence/series formula.	Solve a problem requiring both an arithmetic and a geometric series calculation.	Solve an unfamiliar, multi-step sequence/series problem in a financial or scientific context.	Medium
OL-GE-21	GE	Circle Theorems — Comprehensive Application	Apply the angle-at-centre-is-twice-angle-at-circumference theorem directly.	Apply the angles-in-the-same-segment theorem to find a missing angle.	Solve a multi-step problem requiring three or more circle theorems used together.	High
OL-GE-22	GE	Congruence & Similarity — Formal Proof	Complete a partially-given formal congruence proof.	Construct a formal proof of congruence for a given pair of triangles.	Construct a formal proof of similarity in an unfamiliar multi-step figure.	High
OL-GE-23	GE	Geometric Proof — Multi-Theorem Problems	Identify which theorems are needed for each step of a given multi-step proof.	Construct a proof combining two different theorem types (e.g. circle and triangle).	Construct an original rigorous proof for an unfamiliar diagram requiring three or more theorems.	High
OL-GE-24	GE	Constructions & Loci — Advanced	Construct a locus satisfying a single condition in a real-life context (e.g. a safety zone).	Construct a region satisfying two combined loci conditions.	Solve a real-life problem requiring construction and shading of a region satisfying three combined conditions.	High
OL-GE-25	GE	Three-Dimensional Geometry (Introductory)	Find the length of a space diagonal of a cuboid using the 3D Pythagorean theorem.	Find the angle between a line and a plane in a simple 3D solid.	Solve a multi-step 3D problem combining length and angle calculations in an unfamiliar solid.	High
OL-CG-26	CG	Equation of a Circle — Advanced	Complete the square to convert a circle's general equation to standard form.	Find the points of intersection between a circle and a straight line.	Determine whether a line intersects, is tangent to, or misses a circle, using the discriminant.	High
OL-CG-27	CG	Tangent to a Circle — Coordinate Methods	Find the gradient of the radius to a given point on a circle.	Find the equation of the tangent to a circle at a given point on its circumference.	Find the length of a tangent from an external point to a circle using the distance formula.	High

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
OL-CG-28	CG	Perpendicular Bisector & Loci	Find the equation of the perpendicular bisector of a segment joining two given points.	Use a perpendicular bisector to find a point equidistant from two given points satisfying an additional condition.	Solve a multi-step coordinate loci problem combining a perpendicular bisector with a circle or another line.	High
OL-CG-29	CG	Coordinate Geometry — Multi-Step Proof	Complete a partially-given coordinate proof combining two facts.	Construct a coordinate proof combining three facts (e.g. distance, gradient and circle equation).	Construct an original rigorous coordinate proof for an unfamiliar configuration.	High
OL-MN-30	MN	Surface Area & Volume — Advanced Composite Solids	Calculate the volume of a composite solid formed from three or more basic solids.	Find a missing dimension in a complex composite solid given a partial measurement.	Solve a real-life engineering-style problem requiring surface area and volume reasoning together.	High
OL-MN-31	MN	Mensuration in 3D Coordinate Contexts	Use the distance formula to find a length needed for a mensuration calculation.	Calculate the area of a shape whose vertices are given as coordinates.	Solve a multi-step problem combining coordinate distance calculations with a volume or surface area formula.	High
OL-TR-32	TR	Trigonometric Identities (Introductory)	Use $\sin^2\theta+\cos^2\theta=1$ to find $\cos\theta$ given $\sin\theta$, or vice versa.	Simplify a trigonometric expression using the identity $\tan\theta=\sin\theta/\cos\theta$.	Verify a simple trigonometric identity by manipulating both sides using known identities.	Low
OL-TR-33	TR	Trigonometric Equations (Introductory)	Solve $\sin\theta=k$ or $\cos\theta=k$ for one solution in the range 0°–360°.	Find all solutions of a simple trigonometric equation within 0°–360°.	Solve a trigonometric equation requiring identity substitution before solving (e.g. using $\sin^2\theta+\cos^2\theta=1$).	High
OL-TR-34	TR	Graphs of Sine, Cosine & Tangent	Identify the period and key features of a tangent graph.	Sketch the graph of tangent over 0°–360°, showing its asymptotes.	Compare the graphs of sine, cosine and tangent to solve a problem about where two functions are equal.	High
OL-TR-35	TR	Bearings & 3D Trigonometry	Combine a bearing problem with the sine rule to find a missing distance.	Solve a 3D angle of elevation problem requiring the cosine rule.	Solve a multi-leg navigation problem combining bearings, the sine rule and the cosine rule.	High
OL-TR-36	TR	Sine/Cosine Rule — Advanced Applications	Solve a two-step problem combining the sine rule and the area formula.	Solve a problem requiring the cosine rule followed by the sine rule (or vice versa).	Solve a real-life surveying or navigation problem combining all three trigonometric tools in an unfamiliar context.	High
OL-ST-37	ST	Standard Deviation — Advanced Calculation	Calculate the standard deviation of grouped data using midpoints.	Use a computational formula to calculate standard deviation efficiently.	Interpret and compare standard deviations across two grouped data sets in a real-life context.	Medium
OL-ST-38	ST	Correlation & Scatter Diagrams	Construct a scatter diagram from paired data.	Describe the type and strength of correlation shown in a scatter diagram.	Draw a line of best fit and use it to make and critique a prediction, including its limitations.	High
OL-ST-39	ST	Regression Concepts (Introductory)	Substitute into a given regression equation to make a prediction.	Distinguish between interpolation and extrapolation when using a regression equation.	Critique the reliability of a prediction made using extrapolation far outside the data range.	Medium
OL-ST-40	ST	Comparing & Interpreting Complex Data Sets	Compare two complex data sets using one statistical measure.	Compare two complex data sets using several measures together (e.g. mean, standard	Construct a justified, critical real-world conclusion combining several statistical measures and their limitations.	Medium

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
				deviation, correlation).		
OL-PR-41	PR	Conditional Probability — Formal Treatment	Calculate P(A∩B) and P(B) from given information, then find P(A|B).	Use the conditional probability formula in a two-way table context.	Solve a multi-step problem requiring the conditional probability formula combined with the multiplication rule.	Medium
OL-PR-42	PR	Independent & Dependent Events — Advanced	Use the independence formula to test whether two given events are independent.	Solve a probability problem involving dependent events, using conditional probability.	Solve a multi-stage problem combining independence testing with conditional probability calculation.	Medium
OL-PR-43	PR	Expected Value (Introductory)	Calculate the expected value of a simple scenario with two outcomes.	Calculate the expected value of a scenario with three or more outcomes.	Use expected value to compare two decision options and justify which is better in the long run.	Medium
OL-CO-44	CO	Permutations — Advanced (with Restrictions)	Calculate permutations where a specific pair of items must be adjacent.	Calculate permutations where a specific pair of items must never be adjacent (using complementary counting).	Calculate permutations of a set with repeated items (e.g. letters of a word with repeats).	Medium
OL-CO-45	CO	Combinations — Advanced (with Restrictions)	Calculate combinations where a specific item must be included.	Calculate combinations where a specific item must be excluded.	Solve a combination problem requiring selection from two or more distinct groups with a combined condition.	Medium
OL-CO-46	CO	Combinatorial Problem Solving	Solve a two-step problem requiring one permutation and one combination calculation.	Solve a multi-step counting problem combining several restrictions.	Solve an unfamiliar competition-style combinatorial puzzle combining counting with probability.	Medium
OL-VE-47	VE	Vector Geometry — Ratio of Line Segments	Find the position vector of the midpoint of a segment using vectors.	Find the position vector of a point dividing a segment in a given ratio other than 1:1.	Use vector ratio division to solve a geometric problem within a more complex figure (e.g. a triangle with cevians).	High
OL-VE-48	VE	Vector Proofs — Collinearity & Parallelism	Show that two given vectors are parallel (one is a scalar multiple of the other).	Prove that three given points are collinear using vectors.	Construct a complete vector proof combining collinearity and ratio reasoning in an unfamiliar figure.	High
OL-LR-49	LR	Formal Mathematical Proof — Direct & by Contradiction (Introductory)	Construct a formal direct proof of a stated algebraic or number claim.	Construct a simple proof by contradiction (e.g. proving √2 is irrational is a classic model, but use an accessible O-Level-appropriate claim).	Choose between direct proof and proof by contradiction for an unfamiliar claim and justify the choice.	Low
OL-LR-50	LR	Advanced Logical & Algebraic Reasoning	Solve a puzzle using algebra to represent one logical condition.	Solve a puzzle combining two algebraic conditions with logical deduction.	Solve an unfamiliar competition-style puzzle combining several algebraic and logical conditions.	Medium
OL-PS-51	PS	Advanced Multi-Step Problem Solving	Solve a two-domain advanced problem with familiar numbers.	Solve a problem combining three domains (e.g. trigonometry, algebra and geometry).	Solve an unfamiliar problem combining four or more O-Level domains.	Medium
OL-PS-52	PS	Mathematical Modelling — Optimization (Introductory)	Set up a simple quadratic model for an optimization scenario (e.g. maximizing area for fixed perimeter).	Solve the optimization model using vertex form or a graphical method.	Evaluate the assumptions of an optimization model and discuss how a changed constraint would affect the solution.	Medium

A-Level

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
AL-NT-01	NT	Advanced Number Theory & Proof-Based Reasoning	Construct a direct proof of a straightforward divisibility claim.	Construct a proof involving a claim about prime numbers (e.g. a specific prime cannot divide a given expression).	Construct a rigorous multi-step number theory proof combining several results.	Low
AL-NT-02	NT	Sequences of Primes & Diophantine Reasoning (Enrichment)	Investigate a simple pattern among the first several prime numbers.	Solve a Diophantine-style equation with a small, systematically searchable solution set.	Solve an unfamiliar competition-style number theory puzzle combining primes and integer constraints.	Low
AL-AL-03	AL	Partial Fractions — Full Treatment	Set up the correct partial fraction form for an expression with a repeated linear factor.	Find the unknown constants for a partial fraction decomposition with a repeated linear factor.	Decompose an expression with an irreducible quadratic factor, or an improper fraction requiring prior division.	Low
AL-AL-04	AL	Polynomial Functions — Advanced Factor/Remainder Theorem Applications	Find one unknown coefficient in a polynomial given one factor.	Find two unknown coefficients in a polynomial given two conditions (factors or remainders).	Solve a problem combining the factor theorem with a sketch or inequality about the polynomial's behaviour.	Low
AL-AL-05	AL	Advanced Algebraic Manipulation & Identities	Simplify a moderately complex algebraic expression combining fractions and surds.	Prove a stated algebraic identity by manipulating one side to match the other.	Simplify or prove an identity involving a multi-layered expression requiring several combined techniques.	Low
AL-AL-06	AL	Binomial Expansion (Introductory)	Expand $(a+b)^n$ for a small positive integer n using binomial coefficients.	Find a specific term (e.g. the term in x^3) in a binomial expansion without expanding fully.	Use the binomial theorem to solve a problem involving an unknown coefficient or approximation.	Low
AL-AL-07	AL	Parametric Relationships (Introductory)	Evaluate a pair of parametric equations for a given parameter value.	Eliminate the parameter from a simple pair of parametric equations to find the Cartesian equation.	Interpret the shape traced by a set of parametric equations and identify key features.	High
AL-EL-08	EL	Exponential Functions — Graphs & Modelling	Sketch the graph of a basic exponential function, showing its asymptote and y-intercept.	Use an exponential model to predict a value at a given time.	Evaluate the assumptions and limitations of an exponential model in an unfamiliar real-life context.	High
AL-EL-09	EL	Logarithmic Functions — Graphs & Modelling	Sketch the graph of a basic logarithmic function, showing its asymptote and x-intercept.	Describe the reflective relationship between a logarithmic graph and its corresponding exponential graph.	Use a logarithmic graph to solve an equation graphically and verify algebraically.	High
AL-EL-10	EL	Exponential Growth & Decay — Applications	Calculate a future value given an exponential growth or decay rate.	Solve for the half-life or doubling time of an exponential decay/growth model.	Solve an unfamiliar multi-step problem combining exponential modelling with logarithmic equation solving.	Medium
AL-FN-11	FN	Functions — Advanced Domain/Range with Restrictions	Determine the domain of a function with two combined restrictions (e.g. denominator and root).	Determine the domain and range of a simple piecewise-defined function.	Rigorously justify the domain and range of an unfamiliar function combining several restriction types.	Medium
AL-FN-12	FN	Composite & Inverse Functions — Rigorous Treatment	Verify that two functions are inverses by showing $f(g(x))=x$ and $g(f(x))=x$.	Determine and justify the domain restriction needed for a given function to have an inverse.	Rigorously prove an inverse relationship for an unfamiliar function, including full domain justification.	Medium

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
AL-FN-13	FN	Graph Transformations — Combined & Advanced	Sketch a single stretch (vertical or horizontal) of a given function.	Sketch the graph resulting from two combined transformations applied in sequence.	Describe, in correct order and using function notation, the sequence of three or more transformations mapping one graph to another.	High
AL-FN-14	FN	Rational Functions — Asymptotic Behaviour	Identify the vertical and horizontal asymptotes of a given rational function.	Sketch a rational function graph using its asymptotes and intercepts.	Identify an oblique asymptote for a rational function where the numerator's degree exceeds the denominator's by one.	High
AL-FN-15	FN	Modelling with Functions	Match a described real-life context to the most appropriate function type (linear, quadratic, exponential).	Fit a simple function to given data points and use it to make a prediction.	Evaluate why a chosen function model may fail to fit a real-life context well, and suggest an alternative.	Medium
AL-EQ-16	EQ	Advanced Equation Solving — Combined Algebraic Methods	Solve an equation requiring two combined techniques.	Solve an equation requiring three combined techniques in sequence.	Solve an unfamiliar equation requiring careful strategic planning across several techniques, checking for extraneous solutions.	Low
AL-EQ-17	EQ	Inequalities — Advanced Regions & Systems	Solve a simple rational inequality using critical values and a sign diagram.	Represent a system combining a linear and a quadratic inequality graphically.	Solve an unfamiliar problem requiring a complex combined inequality region with three or more conditions.	High
AL-SQ-18	SQ	Arithmetic & Geometric Series — Advanced Applications	Solve a series problem requiring the sum formula with one unknown parameter.	Solve a problem combining an arithmetic and geometric series in the same real-life scenario.	Solve an unfamiliar, multi-parameter series problem in a financial or scientific modelling context.	Medium
AL-SQ-19	SQ	Sigma Notation — Formal Treatment	Split a sum in sigma notation into two simpler sums.	Use a standard formula (e.g. for Σn) to evaluate a sum in sigma notation.	Evaluate a sum in sigma notation requiring a combination of standard formulas and algebraic manipulation.	Low
AL-SQ-20	SQ	Series Convergence Concepts (Introductory)	State whether a given geometric series converges based on its common ratio.	Explain, qualitatively, why a geometric series with $\|r\| \geq 1$ does not have a finite sum.	Determine the range of a parameter for which a given geometric series converges.	Low
AL-SQ-21	SQ	Recursive Sequences & Modelling	Generate the first several terms of a sequence from a recursive rule.	Use a recursive model to predict a term several steps ahead by iterating the rule.	Build and interpret a recursive model for an unfamiliar real-life situation (e.g. population with a changing rate).	Medium
AL-GE-22	GE	Advanced Euclidean Geometry — Rigorous Proof	Complete a partially-given rigorous proof combining two theorem types.	Construct a rigorous proof combining three theorem types for a given figure.	Construct an original rigorous proof for an unfamiliar, complex figure requiring several theorems and careful justification.	High
AL-GE-23	GE	Circle Geometry — Comprehensive Theorem Application	Apply two circle theorems together in a moderately complex diagram.	Apply three or more circle theorems together to solve a multi-step problem.	Construct a complete proof for an unfamiliar circle configuration requiring careful theorem selection.	High
AL-GE-24	GE	Three-Dimensional Geometric Reasoning	Solve a 3D length problem using the	Solve a 3D angle problem combining	Solve an advanced 3D problem requiring	High

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
			Pythagorean theorem in an unfamiliar solid.	trigonometry with the Pythagorean theorem.	vector methods combined with trigonometric or Pythagorean reasoning.	
AL-CG-25	CG	Equation of a Circle — Advanced Analytical Methods	Set up the system of equations needed to find a circle through three given points.	Solve the system to find the equation of a circle through three given points.	Solve an advanced problem involving a family of circles satisfying a given condition.	High
AL-CG-26	CG	Loci & Coordinate Proof — Advanced	Find the equation of a locus combining a circle condition with a linear condition.	Construct a rigorous coordinate proof of an advanced geometric result.	Solve an unfamiliar multi-condition loci problem combining three or more coordinate geometry concepts.	High
AL-CG-27	CG	Intersections of Lines & Curves	Find the intersection points of a line with a simple quadratic curve.	Use the discriminant to determine whether a line intersects a circle in zero, one or two points.	Solve a real-life problem requiring classification of intersections between a line and an unfamiliar curve.	High
AL-CG-28	CG	Advanced Coordinate Transformations	Find the equation of a circle after a simple translation.	Find the equation of a line or circle after a reflection or scaling.	Find the equation of a curve after a combination of two or more transformations.	High
AL-MN-29	MN	Advanced Mensuration — 3D Composite Reasoning	Calculate the volume of a highly complex composite solid with several component shapes.	Solve a mensuration problem requiring a trigonometric calculation to find a needed dimension first.	Solve an unfamiliar advanced problem combining mensuration, trigonometry and vector reasoning together.	High
AL-TR-30	TR	Trigonometric Identities — Advanced Proof	Use a double angle identity to find $\sin(2\theta)$ or $\cos(2\theta)$ given $\sin\theta$ or $\cos\theta$.	Use a compound angle identity to expand $\sin(A\pm B)$ or $\cos(A\pm B)$.	Prove an advanced trigonometric identity requiring compound and double angle identities together.	Low
AL-TR-31	TR	Trigonometric Equations — General Solutions	Find the general solution of a simple equation such as $\sin\theta=k$.	Solve a trigonometric equation requiring a double angle identity substitution first.	Solve an unfamiliar trigonometric equation requiring several combined identities and general solution reasoning.	High
AL-TR-32	TR	Trigonometric Graphs — Advanced Transformations	Sketch a sine or cosine graph with a changed amplitude.	Sketch a sine or cosine graph with a changed period and a phase shift.	Sketch a trigonometric graph under a combination of all three transformation types and identify its equation.	High
AL-TR-33	TR	Radians & Arc Length (Introductory)	Convert a given angle in degrees to radians, or vice versa.	Calculate arc length or sector area using the radian versions of the formulas ($s=r\theta$, $A=\frac{1}{2}r^2\theta$).	Solve a multi-step problem involving radian measure combined with trigonometric equation solving.	Medium
AL-TR-34	TR	Applications of Trigonometry in Advanced Contexts	Solve a two-step problem combining an identity with the sine or cosine rule.	Solve a three-step problem requiring an equation, an identity, and a rule together.	Solve an unfamiliar competition-style trigonometry problem combining several tools strategically.	High
AL-ST-35	ST	Variance & Standard Deviation — Advanced Treatment	Calculate the new mean after a linear transformation is applied to a data set.	Determine the new standard deviation after a data set is scaled by a constant.	Solve a problem combining two data sets, finding the combined mean and variance.	Low
AL-ST-36	ST	Probability Distributions — Discrete	Verify that a given discrete probability	Find an unknown probability in a distribution table	Construct a full discrete probability distribution table for	Medium

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
			distribution is valid (sums to 1).	using the sum-to-1 condition.	an unfamiliar scenario and use it to answer a question.	
AL-ST-37	ST	Binomial Distribution	Identify whether a scenario satisfies the conditions for a binomial distribution.	Calculate a single binomial probability using the formula.	Find the mean and variance of a binomial distribution and use them to answer a real-life question.	Medium
AL-ST-38	ST	Statistical Modelling — Assumptions & Limitations	State one assumption underlying a given statistical model.	Evaluate whether a given model's assumptions are reasonable for a described real-life context.	Construct a full critical evaluation of an unfamiliar statistical model, including assumptions, limitations and possible improvements.	Low
AL-PR-39	PR	Expected Value & Variance of a Distribution	Calculate E(X) for a simple discrete distribution.	Calculate Var(X) for a simple discrete distribution using $E(X^2) - [E(X)]^2$.	Use E(X) and Var(X) together to compare two decision scenarios and justify a recommendation.	Medium
AL-PR-40	PR	Advanced Conditional Probability & Independence	Solve a two-stage conditional probability problem using a tree diagram.	Solve a problem requiring reversal of conditioning (finding $P(A\|B)$ from $P(B\|A)$) using basic principles.	Solve an unfamiliar multi-stage problem combining conditional probability with independence testing.	High
AL-CO-41	CO	Advanced Permutations & Combinations — Complex Restrictions	Solve a counting problem with two combined restrictions.	Solve a counting problem with three combined restrictions, decomposing into cases.	Solve an unfamiliar competition-style counting problem requiring careful case decomposition and strategic reasoning.	Medium
AL-CO-42	CO	Pigeonhole-Style & Combinatorial Reasoning	Apply the basic pigeonhole principle to a simple existence problem.	Construct a pigeonhole-style argument for a moderately complex scenario.	Solve an unfamiliar competition-style puzzle requiring a non-obvious pigeonhole-style argument.	Low
AL-VE-43	VE	Vector Geometry — Advanced Proofs	Complete a partially-given advanced vector proof.	Construct a vector proof combining ratio division with collinearity in a moderately complex figure.	Construct an original rigorous vector proof for an unfamiliar geometric configuration.	High
AL-VE-44	VE	3D Vectors (Introductory)	Write a 3D vector connecting two given points in column form.	Calculate the magnitude of a 3D vector.	Solve a simple 3D geometric problem using position vectors and vector addition.	High
AL-VE-45	VE	Vector Applications in Mechanics-Style Contexts (Introductory)	Represent a simple displacement scenario as a vector.	Calculate the resultant of two combined vector displacements.	Solve a multi-step real-life problem (e.g. relative motion) using resultant vector reasoning.	High
AL-MA-46	MA	Matrix Notation & Operations	Add or subtract two matrices of the same order.	Multiply two matrices, including a 2×2 by a 2×2.	Perform a multi-step calculation combining several matrix operations, checking that orders are compatible at each step.	Medium
AL-MA-47	MA	Determinants & Inverse Matrices	Calculate the determinant of a 2×2 matrix.	Find the inverse of a 2×2 matrix using the standard formula.	Determine, using the determinant, whether a given matrix is singular, and interpret what this means.	Low
AL-MA-48	MA	Solving Systems Using Matrices	Write a given 2×2 linear system as a matrix equation.	Solve a 2×2 linear system using the inverse matrix method.	Solve a real-life problem by setting up and solving a matrix equation for a linear system.	Low

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
AL-CL-49	CL	Concept of the Derivative & Gradient Functions	Interpret what the derivative of a function represents graphically at a given point.	Estimate the gradient of a curve at a point using a small interval (introductory numerical approach).	Explain, conceptually, why the derivative describes an instantaneous rather than average rate of change.	High
AL-CL-50	CL	Differentiation Rules — Power, Sum, Constant	Differentiate a single power term using the power rule.	Differentiate a polynomial with several terms using the sum/difference rule.	Differentiate a polynomial requiring rewriting first (e.g. expanding brackets or splitting a fraction).	Low
AL-CL-51	CL	Product Rule & Quotient Rule	Differentiate a simple product of two polynomial functions using the product rule.	Differentiate a simple quotient of two polynomial functions using the quotient rule.	Differentiate a function requiring a choice between and correct application of the product or quotient rule within a larger expression.	Low
AL-CL-52	CL	Chain Rule	Differentiate $(ax+b)^n$ using the chain rule.	Differentiate a composite function requiring the chain rule combined with the sum rule.	Differentiate an expression requiring the chain rule combined with the product or quotient rule.	Low
AL-CL-53	CL	Stationary Points & Curve Sketching	Find the stationary point(s) of a simple quadratic function by setting the derivative to zero.	Classify a stationary point as a maximum or minimum using the second derivative or sign test.	Sketch a cubic or quartic function using its stationary points, intercepts and end behaviour together.	High
AL-CL-54	CL	Increasing/Decreasing Functions & Optimization	Determine whether a function is increasing or decreasing at a given point using its derivative.	Set up a simple optimization problem (e.g. maximizing area or minimizing cost) as a function of one variable.	Solve a real-life optimization problem fully, from setup through differentiation to interpreting the result in context.	Medium
AL-CL-55	CL	Concept of Integration — Antiderivatives	Find the antiderivative of a single power term.	Find the general antiderivative of a polynomial with several terms, including +C.	Find a specific antiderivative given an initial condition (e.g. a point the curve passes through).	Low
AL-CL-56	CL	Definite Integration & Area Under a Curve	Evaluate a definite integral of a simple polynomial between given limits.	Use a definite integral to find the area under a curve above the x-axis.	Find the area under a curve that crosses the x-axis, correctly handling the sign of the integral in each region.	High
AL-CL-57	CL	Area Between Two Curves	Find the intersection points of two simple curves algebraically.	Set up and evaluate the integral for the area between a line and a simple curve.	Find the area between two curves that intersect at more than two points, correctly setting up each region.	High
AL-CL-58	CL	Applications of Calculus — Modelling & Rates of Change	Find the rate of change of a quantity at a given instant using differentiation.	Given a displacement function, find velocity and acceleration using differentiation.	Solve an unfamiliar multi-step modelling problem combining differentiation and integration in a real-life or kinematic context.	Medium
AL-LR-59	LR	Rigorous Mathematical Proof — Direct, Contradiction & Induction (Introductory)	Construct a formal direct proof of an A-Level-appropriate claim.	Construct a formal proof by contradiction of a stated claim.	Construct an introductory proof by mathematical induction for a simple summation formula.	Low
AL-LR-60	LR	Advanced Counterexamples & Logical Argument	Test an advanced claim using a specific example to check plausibility.	Construct a counterexample that disproves an advanced A-Level-level claim.	Identify and explain a subtle flaw in a complex, multi-step given mathematical argument.	Low

Code	Domain	Topic	Foundation	Advanced	Challenge	Visual
AL-LR-61	LR	Critique & Evaluation of Mathematical Arguments	State one strength or weakness of a given solution method.	Compare two given solution methods and identify which is more efficient, with justification.	Construct a full critique of an unfamiliar mathematical argument, identifying both strengths and any gaps in rigor.	Low
AL-PS-62	PS	Advanced Mathematical Modelling	Build a simple model of a described situation using one A-Level domain.	Build a model combining two A-Level domains (e.g. functions and calculus) and evaluate its fit.	Complete a full modelling cycle for an unfamiliar complex situation, including refining the model based on identified limitations.	Medium
AL-PS-63	PS	Optimization Problems — Advanced	Use a given constraint to express one variable in terms of another in an optimization scenario.	Solve a constrained optimization problem after reducing it to a single variable.	Solve an unfamiliar advanced optimization problem requiring careful setup, constraint substitution, and interpretation of the result.	Medium
AL-PS-64	PS	Non-Routine Advanced Problem Solving	Solve a non-routine problem with a guided first step, drawing on one A-Level domain.	Solve a non-routine problem combining two or three A-Level domains.	Solve a genuinely unfamiliar, multi-domain competition-style problem requiring an elegant or efficient solution.	Medium

17. Final Quality Control Summary

This curriculum has been reviewed against the following standards:

- Class 9 is appropriately more advanced than Pioneer Level (Class 7–8), introducing full secondary algebra, geometry and trigonometry.
- Class 10 is clearly more advanced than Class 9, adding the discriminant, quadratic inequalities, sine/cosine rules and introductory vectors.
- O-Level has an internationally appropriate secondary mathematics structure, with full circle theorems, sets, formal proof and advanced statistics/probability.
- A-Level has a genuinely advanced mathematics structure — calculus and matrices appear only here — and is not merely O-Level with harder questions.
- The four tracks are clearly differentiated by academic focus, not just by difficulty, with no unnecessary repetition.
- Algebra is sufficiently emphasized throughout and deepens substantially at each track.
- Functions are progressively introduced from Class 9 notation through A-Level asymptotic and transformation analysis.
- Geometry and trigonometry are properly represented and deepen from right-triangle methods to full circle theorems and 3D vector reasoning.
- Statistics and probability are sufficiently developed, culminating in the binomial distribution and expected value/variance at A-Level.
- Number theory and combinatorial reasoning are included, including enrichment-level Diophantine and pigeonhole-style reasoning at A-Level.
- Mathematical proof and justification are developed progressively: proof-like reasoning (Class 9–10) → formal proof (O-Level) → rigorous proof including introductory induction (A-Level).
- Mathematical modelling is included at every track and culminates in advanced calculus-based modelling and optimization at A-Level.
- A-Level calculus is clearly separated from the standard Class 9–10/O-Level curriculum and appears in no other track.
- Challenge questions test mathematical thinking — hidden relationships, strategy, generalization, proof-like reasoning — rather than merely advanced content outside the track's syllabus.
- Every topic can generate high-quality MCQs across the standard question concepts and has clearly defined testing boundaries.
- Learning outcomes are measurable and question-bank ready.
- The curriculum supports future Practice Tests, Mock Tests, Past Papers and Contest Papers across all four tracks.
- The syllabus is 100% original and exclusively branded as the Markhor Junior Mathematics Curriculum; no external competition is mentioned anywhere in this document.
- No copyrighted material has been copied or closely reproduced from any external source.
- The curriculum is scalable for any future Markhor Junior levels beyond the Aspirant Level.

