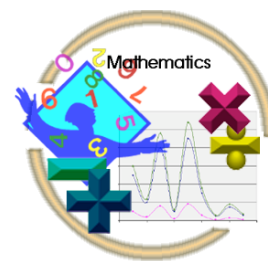


# IB Mathematical Methods

## Grades 9 - 12



### **Standard 1: The student uses a variety of strategies in the problem-solving process.**

- 1.1 Use of a geometric representation to formulate a problem (e.g., use of a parallelogram for vector sums and differences)
- 1.2 Recognize Venn diagrams, tree diagrams, tables of outcomes, and probability formulae as equivalent organizational structures
- 1.3 Use of graphical methods to solve problems
- 1.4 Use of a spreadsheet to solve problems (e.g., terms and sums of sequences and series)
- 1.5 Use a variety of strategies to understand new mathematical content and to develop more efficient solution methods or problem extensions
- 1.6 Understand the components of mathematical modeling (i.e., problem formulation, mathematical model, solution within the model, interpretation of solution within the model, and verify conclusions)
- 1.7 Construct and use algorithms
- 1.8 Understand connections between equivalent representations and corresponding procedures of the same problem situation on mathematical concept (e.g., the zero of a function corresponds to an x-intercept of the graph of the function)
- 1.9 Model a written description of a physical situation with a function, differential equation, or an integral

### **Standard 2: The student understands and applies basic and advanced properties of the concepts of numbers.**

- 2.1 The real number system
- 2.2 Understand and use the laws of exponents and logarithms

### **Standard 3: The student uses basic and advanced procedures while performing the process of computation and estimation.**

- 3.1 Perform vector operations of addition, subtraction, multiplication by a scalar
- 3.2 Calculate the magnitude of a vector
- 3.3 Determine the dot product of two vectors
- 3.4 Calculate the distance between a point and a line, either using vector algebra or the appropriate distance formula
- 3.5 Estimation of the numerical value of a definite integral using the trapezium rule
- 3.6 Solution of equations using the Newton-Raphson Method for approximation of a root

### **Standard 4: The student understands and applies the basic and advanced properties of patterns, function and algebra.**

**Algebra:**

4.1 Finding terms and sums of arithmetic and geometric sequences and series

4.2 The binomial theorem

4.3 Understand the algebraic properties of the dot product of two vectors

4.4 Representing a line with a vector equation

4.5 Transforming between vector and parametric and cartesian forms of a linear equation

**Function:**

4.6 Concept of function, graph, domain and range

4.7 Composite and inverse functions

4.8 Use of a calculator to graph a function, including appropriate choice of window, use of zoom and trace to locate points to a given accuracy and appropriate use of connected or dot mode

4.9 Linear, quadratic, exponential, and reciprocal functions and their graphs

4.10 Application of exponential functions or geometric sequences to solve growth and decay problems

4.11 Behavior of a function with vertical and horizontal asymptotes

4.12 Iteration of a function, including graphical interpretation of convergence to and convergence from a fixed point; recognition that different iterations converge at different rates

**Trigonometry:**

4.13 Basic concepts of sine, cosine and tangent (e.g., domain, range, periodicity, and graphs)

4.14 Basic concepts of the inverse trigonometric functions, including domain and range

4.15 Transformations of the graphs of trigonometric functions

4.16 Solutions of trigonometric equations, including graphical interpretation

4.17 Use of Pythagorean identities and double-angle formulae

4.18 Solution of triangles, using the Laws of Sine and Cosine, including the ambiguous case

4.19 Area of a triangle

**Calculus:**

4.20 Finding derivatives of sine, cosine, tangent, exponential and logarithmic functions

4.21 Derivation using the chain rule

4.22 Differentiation using products and quotient rules

4.23 The second derivative

4.24 Solving problems of application of the first derivative (e.g., tangents, optimization, kinematics) including testing for an extreme value using the sign of the first derivative

4.25 Use of the derivative in determining convergence of an iterative scheme

4.26 Distinction between points of inflexion, maximum points and minimum points

4.27 Integration of power, sine, cosine, exponential functions and the integral of  $1/x$

4.28 Use of initial conditions to evaluate the constant of integration

4.29 Applications of integration to kinematics and in finding the area under a curve

4.30 Integration by substitution

4.31 Simple cases only of integration of composite functions

**Standard 5: The student understands and applies basic and advanced concepts of statistics and data analysis.**

5.1 Concept of population and sample

5.2 Presentation of discrete and continuous data, including use of spreadsheet

5.3 Measures of central tendency (e.g., sample mean, median) including awareness that the population mean is generally unknown and that the sample mean serves as an estimate

5.4 Cumulative frequency; graphs, quartiles and percentiles

5.5 Measures of dispersion; range, interquartile range, sample standard deviation

5.6 Applications of the normal distribution

**Standard 6: The student understands and applies basic and advanced concepts of probability.**

6.1 Probability of combined and mutually exclusive events

6.2 Conditional probability

6.3 Independence of events

6.4 An awareness of the non-exclusivity of 'or' in the union of events

**Standard 7: The student understands and applies basic and advanced properties of the concepts of geometry.**

7.1 Transformations of graphs, including translations, stretches and reflections

7.2 Understanding of the inverse function as a reflection in the line  $y = x$

7.3 Appropriate use of a vector as a displacement in the plane or as a point in space

7.4 Solve vector problems involving interpretation of the dot product (i.e., distinguishing parallel or perpendicular vectors)

7.5 Applications of vectors to simple geometric figures

7.6 Use of the dot product formula to determine the angle between two vectors

7.7 Simple applications of the projection of a vector  $v$  in the direction of  $w$

7.8 Behavior of a function for large  $|x|$

7.9 Interpretation of the geometric significance of the Newton-Raphson Method

7.10 Appreciation of the effect of doubling the number of sub-intervals when using the Trapezium Rule

**Standard 8: The student understands and applies basic and advanced properties of the concepts of measurement.**

8.1 Perform trigonometric operations in radian measure, conversion to degree measure

8.2 Length of an arc

8.3 Area of a sector

**Standard 9: The student understands and applies basic and advanced properties of the structure of mathematics.**

9.1 Awareness of several differing notations for a vector

9.2 Use of the standard notation for probability equations

9.3 Alternative European vocabulary and notations

9.4 Informal ideas of limit and convergence

9.5 Extension of limits to finding horizontal asymptotes