

Diploma Programme subject outline—Group 5: mathematics			
School name	International School of Lausanne	School code	001079
Name of the DP subject	Mathematics		
Level	<input type="checkbox"/> Higher Level	<input checked="" type="checkbox"/> Standard Level	

Course Background

Mathematics is in a sense an international language, and, apart from slightly differing notation, mathematicians from around the world can communicate within their field. Mathematics transcends politics, religion and nationality, yet throughout history great civilizations owe their success in part to their mathematicians being able to create and maintain complex social and architectural structures.

Mathematics Standard Level caters for students with a basic background in mathematics who are competent in the skills they have encountered so far. The majority of SL students will be expecting to need a sound mathematical background for university courses such as chemistry, psychology and business. Others may choose this option simply because they have a strong interest in mathematics. The course introduces students to important concepts through the development of techniques, in a comprehensible and coherent way, rather than insisting on mathematical rigor.

The internally assessed component, the exploration, offers students the opportunity for developing independence in their mathematical learning. Students are encouraged to take a considered approach to various mathematical activities and to explore different mathematical ideas. The exploration also allows students to work without the time constraints of a written examination and to develop the skills they need for communicating mathematical ideas.

Students needing a higher degree of mathematical content should consider Mathematics HL. Students wishing to study a less rigorous mathematics course would be advised to opt for the Mathematical Studies SL course.

Assessment in IB Diploma Mathematics SL

Assessment Components – Higher Level	Weighting (%)
External assessment (3 hours)	
Paper 1 (1.5 hours) This paper consists of section A, short-response questions, and section B, extended-response questions. Questions of varying levels of difficulty and length are set and knowledge of all topics is required for this paper. The emphasis is on problem-solving. Students are not permitted access to any calculator on this paper.	40%
Paper 2 (1.5 hours) This paper consists of section A, short-response questions, and section B, extended-response questions. Questions of varying levels of difficulty and length are set and knowledge of all topics is required for this paper. The emphasis is on problem-solving. A GDC is required for this paper, but not every question will necessarily require its use.	40%
Internal Assessment	
An individual exploration.	20%

The Nature and Timing of Internal Assessment in IB Diploma Mathematics SL

The exploration is a piece of written work that involves investigating an area of mathematics. It enables students to demonstrate the application of their mathematical skills and knowledge, and to pursue their personal interests, without the time limitations and other constraints that are associated with written examinations. The product is a short report written by the student based on a topic chosen by him or her, and it should focus on the mathematics of that particular area. The emphasis is on mathematical communication (including formulae, diagrams, graphs and so on), with accompanying commentary, good mathematical writing and thoughtful reflection.

Internal Assessment in IB Diploma mathematics SL is undertaken in the first term of Year 13. A full first draft is due in mid-November, and the final version in the second week of December (see calendar of deadlines).

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
<p>3.2 Unit circle</p> <p>3.6 Solution of triangles</p>	<p>Definition of $\cos\theta$ and $\sin\theta$ in terms of the unit circle.</p> <p>Definition of $\tan\theta$ as $\frac{\sin\theta}{\cos\theta}$.</p> <p>Exact values of trigonometric ratios of $0, \frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}, \frac{\pi}{2}$ and their multiples.</p> <p>The cosine rule. The sine rule, including the ambiguous case. Area of a triangle.</p> <p>Applications.</p>	<p>The equation of a straight line through the origin is $y = x \tan\theta$.</p> <p>Pythagoras' theorem is a special case of the cosine rule.</p> <p>Link with 4.2, scalar product.</p> <p>Examples include navigation, problems in two and three dimensions, including angles of elevation and depression.</p>	3 weeks	Test on "Algebra and Trigonometry"	<p>Course companion"- Oxford</p> <p>IB Questionbank</p>
<p>Functions and equations</p> <p>2.1 Concept of function</p>	<p>Domain, range; image (value).</p> <p>Composite functions.</p> <p>Identity function. Inverse function.</p> <p>The graph of a function; its equation $y = f(x)$.</p>	<p>A graph is helpful in visualizing the range.</p> <p>Students will only be asked to find the inverse of a one-to-one function.</p>	<p>October</p> <p>4 weeks</p>	<p>Assignment</p> <p>Test</p>	<p>Buchanan, Fensom, Kemp "Mathematics Standard Level, Course</p>

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
<p>2.2 Solving functions graphically</p> <p>2.3 Transformation of graphs</p>	<p>Function graphing skills. Investigation of key features of graphs, such as maximum and minimum values, intercepts, horizontal and vertical asymptotes, symmetry, and consideration of domain and range.</p> <p>Use of technology to graph a variety of functions, including ones not specifically mentioned.</p> <p>The graph of $y=f^{-1}(x)$ as the reflection in the line $y=x$ of the graph of $y=f(x)$.</p> <p>Translations. Reflections (in both axes). Vertical stretch with scale factor p. Stretch in the x-direction with scale factor $\frac{1}{q}$. Composite transformations.</p>	<p>Note the difference in the command terms “draw” and “sketch”.</p> <p>An analytic approach is also expected for simple functions, including all those listed under topic 2.</p> <p>Link to 6.3, local maximum and minimum points.</p> <p>Technology should be used to investigate these transformations.</p> <p>Translation by the vector $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$ denotes horizontal shift of 3 units to the right, and vertical shift of 2 down.</p>			<p>companion”-Oxford</p> <p>IB Questionbank</p>
<p>Circular functions and trigonometry</p> <p>3.4 The circular functions $\sin x$, $\cos x$ and $\tan x$</p>	<p>Their domains and ranges; amplitude, their periodic nature; and their graphs.</p>	<p>Link to 2.3, transformation of graphs.</p>		<p>Assignment</p> <p>Test:</p>	<p>Buchanan, Fensom, Kemp “Mathematics Standard Level, Course</p>

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
<p>3.5 Trigonometric equations</p> <p>3.3 Double angles</p>	<p>Composite functions of the form $f(x)=asin(b(x-c))+d$</p> <p>Solving trigonometric equations in a finite interval, both graphically and analytically.</p> <p>Equations leading to quadratic equations in $\sin x$, $\cos x$ or $\tan x$.</p> <p>The Pythagorean identity $\cos^2x + \sin^2x = 1$. Double angle identities for sine and cosine.</p> <p>Relationship between trigonometric ratios.</p>	<p>Examples include height of tide, motion of a Ferris wheel.</p> <p>Not required: the general solution of trigonometric equations</p> <p>Simple geometrical diagrams and/or technology may be used to illustrate the double angle formulae (and other trigonometric identities).</p>	<p>November</p> <p>3 weeks</p>	<p>Paper 1: Non GDC Paper 2:GDC</p>	<p>companion"-Oxford</p> <p>Smedley and Wiseman "Mathematics Standard Level for the IB Diploma"-Oxford</p> <p>IB Questionbank</p>
<p>Algebra</p> <p>1.2 Exponents and logarithms</p> <p>2.6 The exponential and logarithmic functions</p>	<p>Elementary treatment of exponents and logarithms. Laws of exponents; laws of logarithms.</p> <p>Change of base.</p> <p>Exponential functions and their graphs. Logarithmic functions and their graphs. Relationships between these functions.</p>	<p>Link to 2.6, logarithmic functions.</p> <p>Links to 1.1, geometric sequences; 1.2, laws of</p>	<p>November</p> <p>2 weeks</p>		<p>Buchanan, Fensom, Kemp "Mathematics Standard Level, Course</p>

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
2.7 Exponential equations	Solving exponential equations.	<p>exponents and logarithms; 2.1, inverse functions; 2.2, graphs of inverses; and 6.1, limits.</p> <p>Link to 1.2, exponents and logarithms.</p>			<p>companion"- Oxford</p> <p>IB Questionbank</p>
<p>Algebra</p> <p>1.1 Sequences and series</p> <p>1.3 The binomial theorem</p>	<p>Arithmetic sequences and series; sum of finite arithmetic series; geometric sequences and series; sum of finite and infinite geometric series. Sigma notation. Applications</p> <p>Expansion of $(a+b)^n$, $n \in \mathbb{N}$. Calculation of binomial coefficients using Pascal's triangle and $\binom{n}{r}$</p>	<p>Technology may be used to generate and display sequences in several ways. Link to 2.6, exponential functions</p> <p>Examples include compound interest and population growth.</p> <p>Counting principles may be used in the development of the theorem.</p> <p>$\binom{n}{r}$ should be found using both the formula and technology.</p> <p>Link to 5.8, binomial distribution.</p>	<p>December- January</p> <p>2 weeks</p>		<p>Buchanan, Fensom, Kemp "Mathematics Standard Level, Course companion"- Oxford</p> <p>IB Questionbank</p>

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
		Not required: formal treatment of permutations and formula for nPr .			
Internal Examinations	Exam preparation, internal examinations and feedback.		1 week	January Examinations	
Calculus 6.1 Differentiation theory	Informal ideas of limit and convergence. Limit notation. Definition of derivative from first principles.	Technology should be used to explore ideas of limits, numerically and graphically. Links to 1.1, infinite geometric series; 2.5–2.7, rational and exponential functions, and asymptotes. Use of this definition for derivatives of simple polynomial functions only. Technology could be used to illustrate other derivatives. Link to 1.3, binomial theorem. Use of both forms of notation for the first derivative.	February-April 8 weeks	Assignment Test 1 on differentiation theory: Paper1: non GDC Paper 2:GDC	Buchanan, Fensom, Kemp "Mathematics Standard Level, Course companion"- Oxford Smedley and Wiseman "Mathematics Standard Level for the IB Diploma"- Oxford

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
<p>6.2 Differentiation rules</p>	<p>Derivative interpreted as gradient function and as rate of change.</p> <p>Tangents and normals, and their equations.</p> <p>Derivative of x^n ($n \in \mathbb{Q}$), $\sin x$, $\cos x$, $\tan x$, e^x and $\ln x$.</p> <p>Differentiation of a sum and a real multiple of these functions.</p> <p>The chain rule for composite functions.</p> <p>The product and quotient rules.</p> <p>The second derivative.</p> <p>Extension to higher derivatives.</p>	<p>Identifying intervals on which functions are increasing or decreasing.</p> <p>Use of both analytic approaches and technology. Technology can be used to explore graphs and their derivatives.</p> <p>Not required: analytic methods of calculating limits.</p> <p>Link to 2.1, composition of functions.</p> <p>Technology may be used to investigate the chain rule.</p> <p>Use of both forms of notation.</p>		<p>Assignment</p> <p>Test 2 on differentiation rules:</p> <p>Paper1: non GDC</p>	<p>IB Questionbank</p>
<p>6.3 Differentiation</p>	<p>Local maximum and minimum points.</p>				

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
	<p>Testing for maximum or minimum.</p> <p>Points of inflexion with zero and non-zero gradients.</p> <p>Graphical behaviour of functions, including the relationship between the graphs of f, f' and f''.</p> <p>Optimization.</p> <p>Applications</p>	<p>Using change of sign of the first derivative and using sign of the second derivative.</p> <p>Use of the terms “concave-up” for $f''(x) > 0$, and “concave-down” for $f''(x) < 0$.</p> <p>At a point of inflexion, $f''(x) = 0$ and changes sign (concavity change). $f''(x) = 0$ is not a sufficient condition for a point of inflexion.</p> <p>Both “global” (for large x) and “local” behaviour.</p> <p>Technology can display the graph of a derivative without explicitly finding an expression for the derivative. Use of the first or second derivative test to justify maximum and/or minimum values.</p> <p>Examples include profit, area, volume. Link to 2.2, graphing functions.</p>		Paper 2:GDC	

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
		Not required: points of inflexion where $f''(x)$ is not defined.			
Calculus 6.4 Integration 6.4 Definite integrals	Indefinite integration as anti-differentiation. Indefinite integral of x^n ($n \in \mathbb{Q}$), $\sin x$, $\cos x$, $\frac{1}{x}$ and e^x . The composites of any of these with the linear function $ax + b$. Integration by inspection, or substitution. Anti-differentiation with a boundary condition to determine the constant term. Definite integrals, both analytically and using technology. Areas under curves (between the curve and the x-axis). Areas between curves. Volumes of revolution about the x-axis	 The value of some definite integrals can only be found using technology. Students are expected to first write a correct expression before calculating the area. Technology may be used to enhance understanding of area	May-June 5 weeks	 Assignment Test : Paper1: non GDC Paper 2:GDC	 Buchanan, Fensom, Kemp "Mathematics Standard Level, Course companion"- Oxford Smedley and Wiseman "Mathematics Standard Level for the IB Diploma"- Oxford IB Questionbank

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
6.6 Kinematics	Kinematic problems involving displacement (s), velocity (v) and acceleration (a). Total distance travelled.	and volume.			
Internal examinations	Exam preparation and internal examinations		June 1 week		
Internal assessment: Introduction to the Exploration			June 1 week		
Calculus- Revision 6.1,6.2,6.3 Differentiation 6.4,6.5,6.6 Integration			September- October 3 weeks	Test : Paper1: non GDC Paper 2:GDC	

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
<p>5.3 Cumulative frequency</p> <p>5.4 Linear correlation of bivariate data</p>	<p>Cumulative frequency; cumulative frequency graphs; use to find median, quartiles, percentiles.</p> <p>Linear correlation</p> <p>Pearson's product–moment correlation coefficient r.</p> <p>Scatter diagrams; lines of best fit.</p> <p>Equation of the regression line of y on x. Use of the equation for prediction purposes. Mathematical and contextual interpretation.</p>	<p>Values of the median and quartiles produced by technology may be different from those obtained from a cumulative frequency graph.</p> <p>Independent variable x, dependent variable y.</p> <p>Technology should be used to calculate r. However, hand calculations of r may enhance understanding. Positive, zero, negative; strong, weak, no correlation.</p> <p>The line of best fit passes through the mean point.</p> <p>Technology should be used find the equation. Interpolation, extrapolation.</p> <p>Not required:</p>			

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
<p>5.7 Discrete random variables</p> <p>5.8 Binomial distribution</p> <p>5.9 Normal distribution</p>	<p>probability distributions.</p> <p>Expected value (mean), $E(X)$ for discrete data. Applications.</p> <p>Mean and variance of the binomial Distribution.</p> <p>Normal distributions and curves. Standardization of normal variables (z-values, z-scores). Properties of the normal distribution.</p>	<p>$E(X) = 0$ indicates a fair game where X represents the gain of one of the players. Examples include games of chance.</p> <p>Link to 1.3, binomial theorem. Conditions under which random variables have this distribution. Technology is usually the best way of calculating binomial probabilities.</p> <p>Not required: formal proof of mean and variance.</p> <p>Probabilities and values of the variable must be found using technology. Link to 2.3, transformations. The standardized value (z) gives the number of standard</p>			

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
		deviations from the mean.			
Internal assessment: Work on the Exploration			November 1 week	First draft due in November	
Vectors 4.1 Vectors as displacements in the plane and in three dimensions.	<p>Vectors as displacements in the plane and in three dimensions.</p> <p>Components of a vector; column representation;</p> <p>Algebraic and geometric approaches to the following:</p> <ul style="list-style-type: none"> • the sum and difference of two vectors; the zero vector, the vector $-\mathbf{v}$; • multiplication by a scalar; parallel vectors; • magnitude of a vector; 	<p>Link for three-dimensional geometry, x,y and z-axes.</p> <p>Components are with respect to the unit vectors i, j and k (standard basis).</p> <p>Applications to simple geometric figures are essential.</p> <p>The difference of \mathbf{v} and \mathbf{w} is $\mathbf{v} - \mathbf{w} = \mathbf{v} + (-\mathbf{w})$. Vector sums and differences can be represented by the diagonals of a parallelogram.</p> <p>Multiplication by a scalar can be illustrated by enlargement.</p>	December 4 weeks	Assignment Test: Paper1: non GDC Paper 2:GDC	<p>Buchanan, Fensom, Kemp "Mathematics Standard Level, Course companion"- Oxford</p> <p>Smedley and Wiseman "Mathematics Standard Level for the IB</p>

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
<p>4.2 The scalar product</p> <p>4.3 Vector equation of a line</p> <p>4.4 Intersection of lines</p>	<ul style="list-style-type: none"> • unit vectors; base vectors; i, j and k; • position vectors ; • $\vec{AB} = \vec{OB} - \vec{OA} = \mathbf{b} - \mathbf{a}$. <p>The scalar product of two vectors.</p> <p>Perpendicular vectors; parallel vectors.</p> <p>The angle between two vectors.</p> <p>Vector equation of a line in two and three dimensions: $r = \mathbf{a} + t\mathbf{b}$.</p> <p>The angle between two lines.</p> <p>Distinguishing between coincident and parallel lines.</p> <p>Finding the point of intersection of two lines.</p> <p>Determining whether two lines intersect.</p>	<p>Distance between points A and B is the magnitude of \vec{AB}.</p> <p>The scalar product is also known as the “dot product”. Link to 3.6, cosine rule.</p> <p>For non-zero vectors, $\mathbf{v} \cdot \mathbf{w} = 0$ is equivalent to the vectors being perpendicular.</p> <p>Relevance of a (position) and b (direction). Interpretation of t as time and b as velocity.</p>			<p>Diploma”-Oxford</p> <p>IB Questionbank</p>

Topic/unit (as identified in the IB Diploma subject guide)	Content	Clarification	Allocated time	Assessment	Resources
Internal assessment: Work on the <i>Exploration</i>				Final draft due in December	
Mock Examinations	Exam preparation and examination feedback.		January 3 weeks		
Review	Examination Preparation		February- April 7 weeks		

ToK Concepts Covered in IB Diploma Mathematics SL

Mathematics SL Topic	ToK Concepts
Algebra	<p>How did Gauss add up integers from 1 to 100? Discuss the idea of mathematical intuition as the basis for formal proof.</p> <p>What is Zeno's dichotomy paradox? How far can mathematical facts be from intuition?</p> <p>Are logarithms an invention or discovery?</p>
Functions and equations	<p>Is mathematics a formal language?</p>
Circular functions and trigonometry	<p>Which is a better measure of angle: radian or degree? What are the "best" criteria by which to decide?</p> <p>Trigonometry was developed by successive civilizations and cultures. How is mathematical knowledge considered from a sociocultural perspective?</p>
Statistics and probability	<p>How easy is it to lie with statistics?</p> <p>Can all data be modeled by a mathematical function?</p> <p>To what extent does mathematics offer models of real life? Is there always a function to model data behavior?</p>

Global Understanding in IB Diploma Mathematics SL

At ISL, global understanding is articulated via the following concepts: Conflict Resolution, Social Justice, Values and Perceptions, Sustainable Development, Interdependence, Human Rights, Diversity and Perspectives. Three levels of depth are considered.

- Understanding and appreciation of their own identity
- Understanding and appreciation of the perspectives of others and our interconnectedness
- Promotion of positive intercultural exchange and/or global interaction

Mathematics SL Topic	Global Understanding Concept
Algebra	<p>Diversity</p> <p>These concepts are addressed in mathematics SL through the consideration of how the foundations of modern mathematics were laid down many centuries ago by Arabic, Greek, Indian and Chinese civilizations, among others. No culture has exclusive “ownership” of mathematical concepts. Example: The chess legend (Sissa ibn Dahir), The so-called Pascal’s triangle” was known in China much earlier than Pascal.</p>
Circular functions and trigonometry	<p>Diversity</p> <p>This concept is addressed in mathematics SL through the development of functions, René Descartes (France), Gottfried Wilhelm Leibniz (Germany) and Leonhard Euler (Switzerland).</p> <p>Why are there 360 degrees in a complete turn? Links to Babylonian mathematics.</p>
Statistics and probability	<p>Perceptions</p> <p>This concept is addressed in mathematics SL through the consideration of the benefits of sharing and analyzing data in geography or biology to show patterns and changes. Consideration is also given to the source, quality and availability of some types of data and its effect on the validity of the conclusions that can be drawn.</p> <p>They will also consider if correlation means causation.</p>
Calculus	<p>Perspectives</p> <p>This concept is addressed in mathematics SL through the consideration of the “Calculus Controversy”, an argument between 17th-century mathematicians Isaac Newton and Gottfried Leibniz over who had first invented the mathematical study of change, calculus. It is a question that had been the cause of a major intellectual controversy, one that began simmering in 1699 and broke out in full force in 1711.</p>

Development of the IB learner profile in IB Diploma Mathematics SL

Mathematics SL Topic	Contribution to the development of the attribute(s) of the IB learner profile
All topics	<p>Communicators Mathematics SL students are shown through the links made with other subjects, how mathematics is a language in itself that is central to the understanding of events that occur in our world. They are taught to interpret and express problems using various mathematical forms, both on paper and using technology (including diagrams, graphs and many different forms of notation) .</p> <p>Reflective Mathematics SL students are encouraged to regularly consider the reasonableness of their responses to problems in terms of its context and also consider the relevance of their response to other areas of their knowledge. By considering the interrelationships between what they are learning in this subject and their other IB subjects, they will further see the relevance of mathematics to their own lives.</p>

Development of Approaches to Learning in IB Diploma Mathematics SL

Topic	ATL Skill Category (<i>Communication/ Social/ Self Management/ Research/ Thinking</i>)	Activities that support the development of these skills
Internal assessment	Communication/Reflection	The emphasis is on using mathematical communication (including formulae, diagrams, graphs and so on), with accompanying commentary, good mathematical writing and thoughtful reflection.
Calculus	Thinking	Throughout the course, particularly in the latter stages of this unit, students are exposed to challenging problems that develop logical, critical and creative thinking, and patience and persistence in problem-solving.