Guidelines for the Exploration
(Internal Assessment)

The internally-assessed component in this course is a mathematical exploration. This is a short report written by you based on a topic chosen by you, and it should focus on the mathematics of that particular area. The emphasis is on mathematical communication (including formulae, diagrams, graphs, tables and so on), with your own focus, with me providing feedback via, for example, discussion and interview. This will allow you to develop areas of interest to them without a time constraint as in an examination, and allow you to experience a feeling of success.

In developing your exploration, you should aim to make use of mathematics learned as part of the course. The mathematics used should be commensurate with the level of the course–that is, it should be similar to that suggested in the syllabus. It is not expected that you produce work that is outside the syllabus–however, this will not be penalized.

Ethical guidelines should be adhered to throughout the planning and conducting of the exploration.

The final report should be approximately **12-20 pages** long with **double line spacing**. It can be either word processed or handwritten. You should be able to explain all stages of your work in such a way that demonstrates clear understanding. While there is no requirement that you present your work in class, it should be written in such a way that your peers would be able to follow it fairly easily. The report should include a detailed **bibliography**, and sources need to be referenced in line with the IB academic honesty policy. **Direct quotes must be acknowledged**.

The following details should be stated on the cover page of the exploration:

- **title of the exploration**
- **number of pages.**

The references are not assessed. However, if they are not included in the final report it may be flagged in terms of academic honesty.

The exploration is internally assessed by me and externally moderated by the IB using assessment criteria that relate to the objectives for mathematics. Each exploration is assessed against the **five criteria** listed on the following pages. The assessment **criteria A to D** are the same for both SL and HL. **Criterion E** "Use of mathematics" is different for SL and HL.

The final mark for each exploration is the sum of the scores for each criterion. The maximum possible final mark is 20.

You will not receive a grade for your mathematics course if you have not submitted an exploration.

Criterion A: Presentation – 4 marks

The "presentation" criterion assesses the organization and coherence of the exploration.

A **coherent** exploration is logically developed, easy to follow and meets its aim. This refers to the overall structure or framework, including introduction, body, conclusion and how well the different parts link to each other.

A **well-organized** exploration includes an introduction, describes the aim of the exploration and has a conclusion. Relevant graphs, tables and diagrams should accompany the work in the appropriate place and not be attached as appendices to the document. Appendices should be used to include information on large data sets, additional graphs, diagrams and tables.

A **concise** exploration does not show irrelevant or unnecessary repetitive calculations, graphs or descriptions.

The use of technology is not required but encouraged where appropriate. However, the use of analytic approaches rather than technological ones does not necessarily mean lack of conciseness, and will not be penalized. This does not mean that repetitive calculations are condoned.

Criterion B: Mathematical Communication – 4 marks

The "mathematical communication" criterion assesses to what extent you have:

- used appropriate mathematical language (notation, symbols, terminology). Calculator and computer notation is acceptable only if it is software generated. Otherwise it is expected that you use appropriate mathematical notation in your work
- defined key terms and variables, where required
- used multiple forms of mathematical representation, such as formulae, diagrams, tables, charts, graphs and models, where appropriate
- used a deductive method and set out proofs logically where appropriate

Examples of level 1 can include graphs not being labelled, consistent use of computer notation with no other forms of correct mathematical communication.

Level 4 can be achieved by using only one form of mathematical representation as long as this is appropriate to the topic being explored. For level 4, any minor errors that do not impair clear communication will not be penalized.

Criterion C: Personal engagement – 3 marks

The "personal engagement" criterion assesses the extent to which you engage with the topic by exploring the mathematics and making it your own. It is not a measure of effort.

Personal engagement may be recognized in different ways. These include thinking independently or creatively, presenting mathematical ideas in your own way, exploring the topic from different perspectives, making and testing predictions.

There must be evidence of personal engagement demonstrated in your work. It is not sufficient that I notice that you were highly engaged during class time.

Textbook style explorations or reproduction of readily available mathematics without your own perspective are unlikely to achieve the higher levels.

Significant: You demonstrate authentic personal engagement in the exploration on a few occasions and it is evident that these drive the exploration forward and help the reader to better understand your intentions.

Outstanding: You demonstrate authentic personal engagement in the exploration in numerous instances and they are of a high quality. It is evident that these drive the exploration forward in a creative way. It leaves the impression that you have developed, through your approach, a complete understanding of the context of the exploration topic and the reader better understands your intentions.

Criterion D: Reflection – 3 marks

The "reflection" criterion assesses how you review, analyze and evaluate the exploration. Although reflection may be seen in the conclusion to the exploration, it should also be found throughout the exploration.

Simply describing results represents **limited reflection**. Further consideration is required to achieve the higher levels.

Some ways of showing **meaningful reflection** are: linking to the aims of the exploration, commenting on what they have learned, considering some limitation or comparing different mathematical approaches.

Critical reflection is reflection that is crucial, deciding or deeply insightful. It will often develop the exploration by addressing the mathematical results and their impact on your understanding of the topic. Some ways of showing critical reflection are: considering what's next, discussing implications of results, discussing strengths and weaknesses of approaches, and considering different perspectives.

Substantial evidence means that the critical reflection is present throughout the exploration. If it appears at the end of the exploration it must be of high quality and demonstrate how it developed the exploration in order to achieve a level 3.

Criterion E: Use of mathematics—SL – 6 marks

The "Use of mathematics" SL criterion assesses to what extent you use mathematics that is **relevant** to the exploration.

Relevant refers to mathematics that supports the development of the exploration towards the completion of its aim. Overly complicated mathematics where simple mathematics would suffice is not relevant.

You are expected to produce work that is **commensurate with the level** of the course, which means it should not be completely based on mathematics listed in the prior learning. The mathematics explored should either be part of the syllabus, or at a similar level.

A key word in the descriptor is **demonstrated**. The command term demonstrate means "to make clear by reasoning or evidence, illustrating with examples or practical application". Obtaining the correct answer is not sufficient to demonstrate understanding (even some understanding) in order to achieve level 2 or higher.

For knowledge and understanding to be **thorough** it must be demonstrated throughout.

The mathematics can be regarded as **correct** even if there are occasional minor errors as long as they do not detract from the flow of the mathematics or lead to an unreasonable outcome.

You are encouraged to use technology to obtain results where appropriate, but **understanding must be demonstrated** in order to achieve higher than level 1, for example merely substituting values into a formula does not necessarily demonstrate understanding of the results.

The mathematics only needs to be what is required to support the development of the exploration. This could be a few small elements of mathematics or even a single topic (or sub-topic) from the syllabus. It is better to do a few things well than a lot of things not so well. If the mathematics used is relevant to the topic being explored, commensurate with the level of the course and understood by you, then it can achieve a high level in this criterion.

Criterion E: Use of mathematics—HL – 6 marks

The "Use of mathematics" HL criterion assesses to what extent you use **relevant** mathematics in the exploration.

You are expected to produce work that is **commensurate with the level** of the course, which means it should not be completely based on mathematics listed in the prior learning. The mathematics explored should either be part of the syllabus, at a similar level or slightly beyond. However, mathematics of a level slightly beyond the syllabus is **not** required to achieve the highest levels.

A key word in the descriptor is **demonstrated**. The command term demonstrate means to make clear by reasoning or evidence, illustrating with examples or practical application. Obtaining the correct answer is not sufficient to demonstrate understanding (even some understanding) in order to achieve level 2 or higher.

For knowledge and understanding to be **thorough** it must be demonstrated throughout. Lines of reasoning must be shown to justify steps in the mathematical development of the exploration.

Relevant refers to mathematics that supports the development of the exploration towards the completion of its aim. Overly complicated mathematics where simple mathematics would suffice is not relevant.

The mathematics can be regarded as **correct** even if there are occasional minor errors as long as they do not detract from the flow of the mathematics or lead to an unreasonable outcome. **Precise** mathematics is error-free and uses an appropriate level of accuracy at all times.

Sophistication: To be considered as sophisticated the mathematics used should be commensurate with the HL syllabus or, if contained in the SL syllabus, the mathematics has been used in a complex way that is beyond what could reasonably be expected of an SL student. Sophistication in mathematics may include understanding and using challenging mathematical concepts, looking at a problem from different perspectives and seeing underlying structures to link different areas of mathematics.

Rigor involves clarity of logic and language when making mathematical arguments and calculations. Mathematical claims relevant to the development of the exploration must be justified or proven.

You are encouraged to use technology to obtain results where appropriate, but **understanding must be demonstrated** in order to achieve level 1 or higher, for example merely substituting values into a formula does not necessarily demonstrate understanding of the results.

The mathematics only needs to be what is required to support the development of the exploration. This could be a few small elements of mathematics or even a single topic (or sub-topic) from the syllabus. It is better to do a few things well than a lot of things not so well. If the mathematics used is relevant to the topic being explored, commensurate with the level of the course and understood by you, then it can achieve a high level in this criterion.