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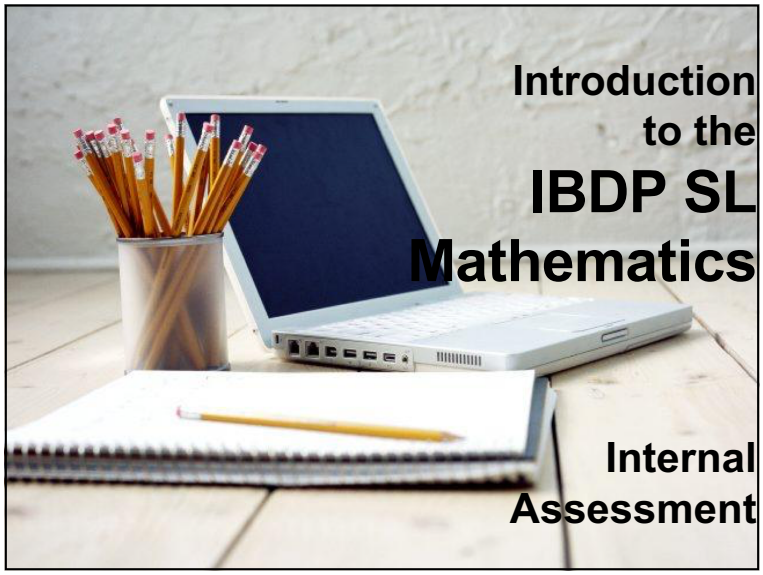


Mathematical Exploration (Internal Assessment)

An opportunity for you to show your knowledge and skills *and* to pursue your personal interests *without* the time limitations found in typical assessments.

FAQ

What is the difference between a mathematical exploration and an extended essay in mathematics?

The criteria are completely different. It is intended that the exploration is to be a much less extensive piece of work than a mathematics extended essay. The intention is for students to "explore" an idea rather than have to do the formal research demanded in an extended essay.

Students can choose from a wide variety of activities.
For example, *modelling, investigations and applications of mathematics.*

The exploration should be approximately 12-20 pages long with double line spacing, including diagrams and graphs, but excluding the bibliography. However, it is the quality of the mathematical writing that is important, not the length.

The specific purposes of the exploration are to:

- → develop students' personal insight into the nature of mathematics and to develop their ability to ask their own questions about mathematics
- → provide opportunities for students to complete a piece of mathematical work over an extended period of time
- → enable students to experience the satisfaction of applying mathematical processes independently
- → provide students with the opportunity to experience for themselves the beauty, power and usefulness of mathematics
- → encourage students, where appropriate, to discover, use and appreciate the power of technology as a mathematical tool
- → enable students to develop the qualities of patience and persistence, and to reflect on the significance of their work
- → provide opportunities for students to show, with confidence, how they have developed mathematically.

Time to Complete

(Internal Deadline: Jan 2021)

10 hours of class time	10 hours of your own time

It is recommended that a total of approximately 10-15 hours of teaching time should be allocated to the work. This should include:
 	
→ time for the teacher to explain to students the requirements of the exploration
→ class time for students to work on the exploration and ask questions
→ time for consultation between the teacher and each student
→ time to review and monitor progress, and to check authenticity.
	• Planning your exploration, doing research to help select an appropriate topic
	• Researching, collecting and organising your data and/or information
	• Applying mathematical processes:
	  ▪ Ensuring that all of your results are derived using logical deductive reasoning
	  ▪ Ensuring that your proofs (when necessary) are coherent and correct
	• Demonstrating mathematical communication and presentation:
	  ▪ Checking that your notation and terminology are consistently correct
	  ▪ Adding diagrams, graphs or charts where necessary
	  ▪ Making sure your exploration is clearly structured and reads well

Academic Honesty

This is extremely important in all your work. Make sure that you have read and are familiar with the IB Academic Honesty document.

Academic Honesty means:

- that your work is authentic
- that your work is your own intellectual property
- that you conduct yourself properly in written examinations
- that any work taken from another source is properly cited.

Authentic work:

- is work based on your own original ideas
- can draw on the work and ideas of others, but this must be fully acknowledged (e.g. in footnotes and a bibliography)
- must use your own language and expression – for both written and oral assignments
- must acknowledge all sources fully and appropriately (e.g. in a bibliography).

Malpractice

The IB defines **malpractice** as 'behavior that results in, or may result in, the candidate or any other candidate gaining an unfair advantage in one or more assessment components'.

Malpractice includes:

- plagiarism – copying from others' work, published or otherwise
- collusion – working secretly with at least one other person in order to gain an undue advantage. This includes having someone else write your exploration, and passing it off as your own
- duplication of work
- any other behavior that gains an unfair advantage.

Collaboration and collusion

It is important to understand the distinction between collaboration (which is allowed) and collusion (which is not).

Collaboration

In several subjects, including mathematics, you will be expected to participate in group work. It is important in everyday life that you are able to work well in a group situation. Working in a group entails talking to others and sharing ideas. Every member of the group is expected to participate equally and it is expected that all members of the group will benefit from this collaboration. However, the end result must be your own work, even if it is based on the same data as the rest of your group.

Collusion

This is when two or more people work together to intentionally deceive others. Collusion is a type of plagiarism. This could be working with someone else and presenting the work as your own or allowing a friend to copy your work.

Technology

...

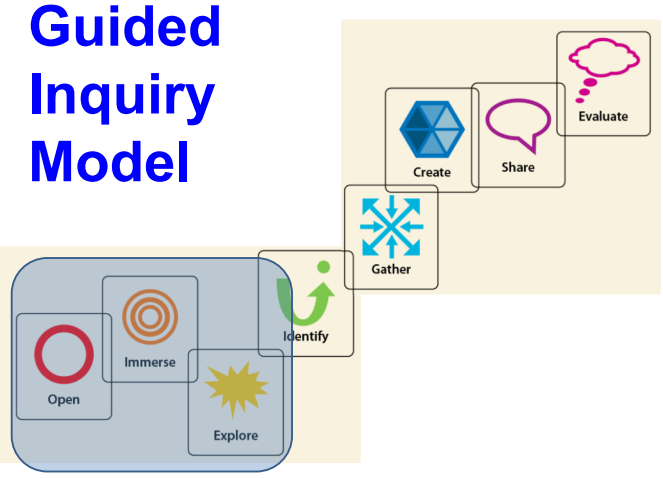
TOP 5 Tips:

1. Choose a topic that: i) you are interested in; ii) involves SL math; iii) can be concise (~~6 - 12~~ 12 - 20 pages), and; iv) shows personal engagement
2. Aim and objective must involve doing mathematics! Keep focused on the aim while using relevant mathematics.
3. The work MUST BE YOUR OWN. However, do ask for help, advice, feedback, and support along the way!
4. Understand the assessment Criteria (how you will be graded) and refer back to the Criteria frequently as you create your report.
5. This is a chance to earn a significant portion of your total grade (20%) on your own terms so select a topic you love and enjoy!

Summer work:
Brainstorming
Interests and Ideas

Summer's goal is to brainstorm as many ideas as possible. The goal is **NOT** yet to select your IA Topic. Therefore, if you already have an idea, be ***open-minded*** , allowing new ideas to emerge and flow freely.

Guided Inquiry Model



Task 1:

Consider the stimuli on the next slide.

1. Create your own list of stimuli based on personal or intellectual interests.
2. Create a detailed, free-flowing Mind Map (see samples on following slides) that takes your personal stimuli and extends them out into dozens of ideas questions, and potential paths for inquiry.

Sample Stimuli:

• sport	• architecture
• archaeology	• codes
• computers	• the internet
• algorithms	• communication
• cell phones	• tiling
• music	• population
• sine	• agriculture
• musical harmony	• viruses
• motion	• health
• *e*	• dance
• electricity	• play
• water	• pi (π)
• space	• geography
• orbits	• biology
• food	• business
• volcanoes	• economics
• diet	• physics
• Euler	• chemistry
• games	• information technology in a global society
• symmetry	• psychology

Before Generating Stimuli:

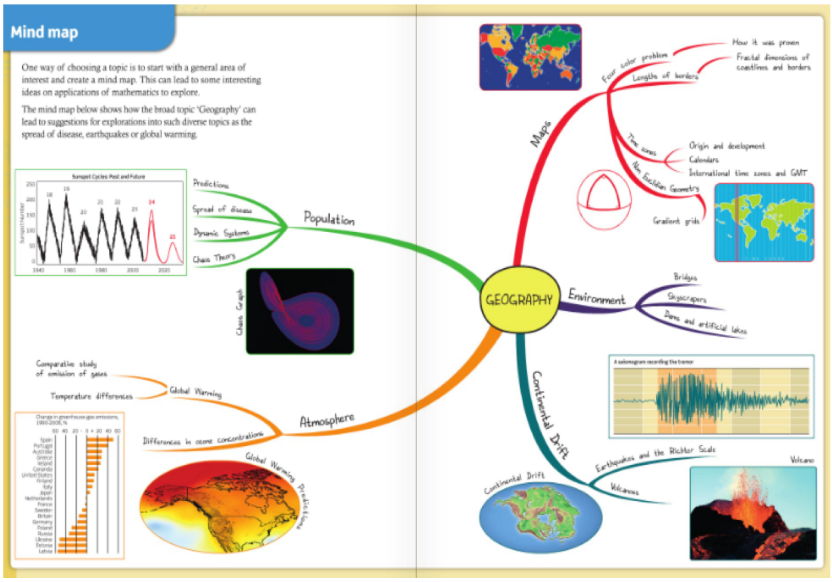
These questions may help you

- What areas of the syllabus are you enjoying most?
- What areas of the syllabus are you performing best in?
- Would you prefer to work on purely analytical work or on modelling problems?
- Have you discovered, through reading or talking to peers on other mathematics courses, areas of mathematics that might be interesting to look into?
- What mathematics is important for the career that you eventually hope to follow?
- What are your special interests or hobbies? Where can mathematics be applied in this area?

Sample Mind Map

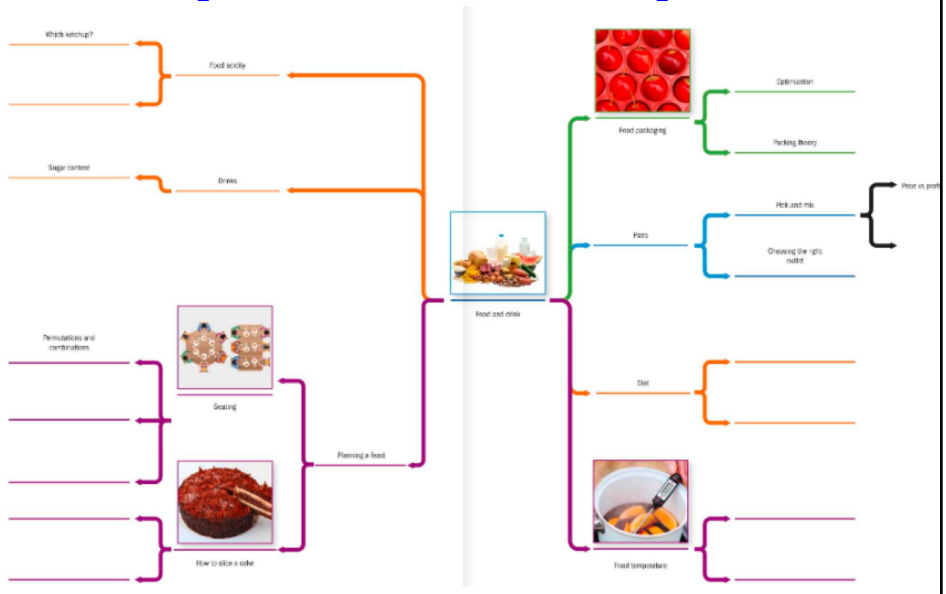
(begins with the "water" stimuli)

Sample Mind Map 2



Sample Mind Map 3

Sample Mind Map 4



Immerse

- Build background knowledge
- Connect to content
- Discover interesting ideas

– As a community

Explore

- Explore interesting ideas
- Look around
- Dip in

Task 2:

Immerse yourself in and explore 3 of the ideas that you generated in your detailed Mind Map. Your Map should have dozens and dozens of ideas. Select those that are most interesting to you.

Create a document or use the fillable template attached in which, for your 3-5 ideas, you do the following:

1. Ask questions like those given below
2. Document the results of online research that takes you deeper into the topics
3. **Connect to content**: using our Course Syllabus, document specific syllabus topics that could help you explore these topics and ideas

Why...?
What are the reasons...?
What if...?
What is the purpose of...?
How would it be different if...?
Suppose that...?
What if we knew...?
What would change if...?

Math AI - Choosing a Project

Choose your favourite projects from your class discussion and write their titles in the table below. Fill in the table to help you decide which will be the best project for you.

Use this space to make a note of any projects you might be interested in

Project Title →			
Short description of the project – what will you investigate?			
Why are you interested in this?			
Will you have to collect any information? What information, and where will you get it from?			

Which mathematical skills will you be able to use? (Look at the list of skills to help you with this)			

A List of Mathematical Skills

This is a list of the skills that you may want to demonstrate in your project. Remember that you need to show the examiner that you can work with a high level of mathematical skills.

- Arithmetic Sequences
- Geometric Sequences
- Geometric properties – triangles, quadrilaterals, polygons, circles, cubes, cuboids, cylinders, prisms, spheres, trigonometry ☺
- Functions from real life ☺
- Scatter diagrams
- Lines of best fit and correlation ☺
- Frequency tables
- Pie charts
- Bar charts
- Frequency histograms
- Frequency density histograms ☺
- Cumulative frequency tables
- Cumulative frequency curves

You must demonstrate AT LEAST:

- *2 standard skills*
- *1 higher level skill to achieve the top marks*

Key:

☺= Higher level skill

- Percentiles
- Mean, Median, Mode and range
- Standard Deviation ☺
- Chi squared test ☺
- Probability

Internal assessment criteria

Standard Level IB Math Exploration Rubric

	A: Communication (4) This criterion assesses the organization and coherence of the exploration. A well-organized exploration includes an introduction, has a rationale (which includes explaining why this topic was chosen), describes the aim of the exploration and has a conclusion. A coherent exploration is logically developed and easy to follow. *Graphs, tables and diagrams should accompany the work in the appropriate place and not be attached as appendices to the document.*	**B: Mathematical presentation (3)** • use appropriate mathematical language (notation, symbols, terminology) • define key terms, where required • use multiple forms of mathematical representation, such as formulae, diagrams, tables, charts, graphs and models, where appropriate. *Students are expected to use mathematical language when communicating mathematical ideas, reasoning and findings.* *Students are encouraged to choose and use appropriate ICT tools such as graphic display calculators, screen shots, graphing, spreadsheets, databases, drawing and word-processing software, as appropriate, to enhance mathematical communication.*	**C: Personal engagement (4)** This criterion assesses the extent to which the student engages with the exploration and makes it their own. Personal engagement may be recognized in different attributes and skills. These include thinking independently and/or creatively, addressing personal interest and presenting mathematical ideas in their own way.	**D: Reflection (3)** This criterion assesses how the student reviews, analyses and evaluates the exploration. Although reflection may be seen in the conclusion to the exploration, it may also be found throughout the exploration.	**E: Use of mathematics (6)** This criterion assesses to what extent students use mathematics in the exploration. *Students are expected to produce work that is commensurate with the level of the course. The mathematics explored should either be part of the syllabus, or at a similar level or beyond. It should not be completely based on mathematics listed in the prior learning. If the level of mathematics is not commensurate with the level of the course, a maximum of two marks can be awarded for this criterion. 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.*
0	The exploration **does not reach the standard** described by the descriptors below.	The exploration **does not reach the standard** described by the descriptors below.	The exploration **does not reach the standard** described by the descriptors below.	The exploration **does not reach the standard** described by the descriptors below.	The exploration **does not reach the standard** described by the descriptors below.
1	The exploration has **some coherence**.	There is **some appropriate** mathematical presentation.	There is evidence of **limited** or **superficial** personal engagement.	There is evidence of **limited** or **superficial** reflection.	**Some relevant** mathematics is used.
2	The exploration has **some coherence** and shows **some organization**.	The mathematical presentation is **mostly appropriate**.	There is **evidence of some** personal engagement.	There is evidence of **meaningful** reflection.	**Some relevant** mathematics is used. **Limited understanding** is demonstrated.
3	The exploration is **coherent** and **well organized**.	The mathematical presentation is **appropriate throughout**.	There is **evidence of significant** personal engagement.	There is **substantial** evidence of critical reflection.	**Relevant mathematics** commensurate with the level of the course is used. **Limited understanding** is demonstrated.
4	The exploration is **coherent**, **well organized**, **concise** and **complete**.		There is **abundant evidence** of **outstanding** personal engagement.		**Relevant mathematics** commensurate with the level of the course is used. The mathematics explored is **partially correct**. **Some knowledge** and **understanding** are demonstrated.
5					**Relevant mathematics** commensurate with the level of the course is used. The mathematics explored is **mostly correct**. **Good knowledge** and **understanding** are demonstrated.
6					**Relevant mathematics** commensurate with the level of the course is used. The mathematics explored is **correct**. **Thorough knowledge** and **understanding** are demonstrated.

IB DP SL Mathematical Exploration
Assessment Criteria with Additional Notes

Criterion A: Presentation	
0. The exploration does not reach the standard described by the descriptors below. 1. The exploration has some coherence or some organization. 2. The exploration shows some coherence and shows some organization 3. The exploration is coherent and well organized. 4. The exploration is coherent, well organized, and concise. **Tips:** • Clearly explain what is being done in a concise and focused manner so the reader is not left guessing • If in reading your work the reader has to pause to clarify where a result came from or how it was achieved, this generally indicates flawed communication. • Avoid **over describing** mathematical expressions / methods using words – mathematics is itself a language. • Avoid repeating yourself	A **well-organized** exploration includes a **rationale** (explanation why this topic was chosen), an introduction (context), a clearly defined **aim** of the exploration. Relevant graphs, tables and diagrams should accompany the work at the appropriate times in the paper. **References** are cited. The paper ends with a meaningful **conclusion**. **Appendices** should be used to include information on large data sets, additional graphs, diagrams and tables. 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. It "reads well" and graphs, tables, diagrams are included at correct/necessary places. A **concise** exploration focuses on and achieves the aim, explains all stages in the exploration clearly and concisely, and avoids irrelevancies, 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 should not be penalized. This does not mean that repetitive calculations are condoned. Incorporate clear and sufficient explanations for the written mathematics so that your peers can easily follow your argument.
Criterion B: Mathematical Communication	
0. The exploration does not reach the standard described by the descriptors below. 1. The exploration contains some relevant mathematical communication which is partially appropriate. 2. The exploration contains some relevant appropriate mathematical communication. 3. The mathematical communication is relevant, appropriate, and is mostly consistent. 4. The mathematical communication is relevant, appropriate, and consistent throughout. **Tips:** • Select the best form of presentation (ie: do not represent the same data using two different diagrams unnecessarily) • If you include a mathematical process or diagram, then always refer to it or comment on it; if there is no comment, it is irrelevant • Use technology to enhance communication (ex: technology can reduce or automate repetitive calculations) • Express results to an appropriate degree of accuracy with reasons • Label scales and axis clearly in graphs • Set out proofs clearly and logically	This criterion assesses **the appropriateness of the mathematics**, in particular, to what extent the student has: - used appropriate mathematical language (**notation, symbols, terminology**) when communicating mathematical ideas, reasoning, and findings. *Calculator/computer notation is acceptable only if it is software generated. Otherwise, students must use appropriate mathematical notation. - 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. Students are **encouraged to choose and use appropriate ICT tools** such as graphic display calculators, screenshots, mathematical software, spreadsheets, databases, drawing and word-processing software, as appropriate, **to enhance mathematical communication**.