INFORMATION FOR IB MATH SL EXPLORATION

What is the Exploration?
This is a report (approximately 6-12 pages) 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. **The math should be math from this course syllabus or beyond.**

A student should develop his or her own focus, with the teacher providing feedback via, for example, discussion and interview. This will allow the students to develop area(s) of interest to them without a time constraint as in an examination, and allow all students to experience a feeling of success.

Students should be able to explain all stages of their work in such a way that demonstrates clear understanding. It should be written in such a way that their 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 Purpose of the Exploration:
The exploration is intended to provide students with opportunities to increase their understanding of mathematical concepts and processes, and to develop a wider appreciation of mathematics. These are noted in the aims of the course, in particular, aims 6–9 (applications, technology, moral, social and ethical implications, and the international dimension). It is intended that, by doing the exploration, students benefit from the mathematical activities undertaken and find them both stimulating and rewarding.
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.

Exploration Grading:
The exploration is internally assessed by the teacher. For those taking the exam in May, it is also externally moderated by the IB using assessment criteria that relate to the objectives for mathematics SL. A student's mark (grade) on the exploration will count for 20% of the final IB mathematics exam grade. The other 80% will come from Paper I and Paper II (which are actually exams; they call them papers in the IB program). **For those not taking the exam in May, the Exploration will count as part of your final exam.**

Each exploration is assessed against the following five criteria. The final mark for each exploration is the sum of the scores for each criterion. The maximum possible final mark (grade) is 20.

Criterion A	Communication
Criterion B	Mathematical Presentation
Criterion C	Personal Engagement
Criterion D	Reflection
Criterion E	Use of Mathematics

Suggestions in components necessary for a successful exploration:

· Criterion A: Communication (4/20 marks)

* You must include:
  * An *introduction* in which you should discuss the context of the exploration
  * A *rationale* which should include an explanation of why you chose this topic.
  * A description of the *aim* of the exploration which should be clearly identifiable.
  * A *conclusion*.
* Must "read well" which means it must be logically developed, easy to follow and concise (avoid irrelevancies).
* Graphs, tables and diagrams should be clearly labelled.
* 6 to 12 pages using a 11 -12 point easily read font (ie. Times New Roman)
* References must be cited. Your exploration should contain appropriate footnotes and a bibliography.

· Criterion B: Mathematical Presentation (3/20 marks)

* Use appropriate mathematical language (notation, symbols and terminology)
* Use multiple forms of mathematical representation such as formulae, diagrams, tables, charts, and graphs.
* Choose and use appropriate ICT tools such as graphic display calculators, mathematical software, spreadsheets, databases, drawing and word-processing software.
* Define key terms and explicitly define variables.
* Express your results to an appropriate degree of accuracy.
* Include scales and labels on graphs; include concise, descriptive headings on tables.
* Do not use calculator notation (ie. use 2^x and not 2^x)

· Criterion C: Personal Engagement (4/20 marks)

* You should choose a topic that you are genuinely interested in as it will be easier to display personal engagement.
* Suggestions for demonstrating personal engagement (this must be in your paper):
  * Thinking and working independently; Thinking creatively
  * Addressing your personal interests
  * Presenting mathematical ideas in your own way, using simple language to describe complex ideas
  * Asking questions, making conjectures and investigating mathematical ideas
  * Looking for and creating mathematical models for real-world situations
  * Considering historical and global perspectives
  * Exploring unfamiliar mathematics

· Criterion D: Reflection (3/20 marks)

* Although reflection may be seen in the conclusion to the exploration, it may also be found throughout the exploration. This assesses how well you *review*, *analyse* and *evaluate* your exploration.
* You can show reflection by:
  * Discussing the implications of your results
  * Considering the significance of your findings and results
  * Stating possible limitations and/or extensions to your results
  * Making links to different fields and/or areas of mathematics.

· Criterion E: Use of Mathematics (6/20 marks)

* The mathematics you explore should be either part of the syllabus, or at a similar level (or beyond) (NOT mostly Prerequisites). See pg 23 – 44 of the IB Course Intro & Syllabus under Important Documents at http://fchsmrshaley.weebly.com/ib-math-sl.html .
* *If the level of mathematics is inadequate, your maximum achievement level will be two marks.*
* Your mathematics must clearly demonstrate that you fully understand the mathematics.

Choosing a Topic

Over the summer start thinking about a topic that interests you, because then you will enjoy working on your exploration, you will put more effort into the exploration, and you will be able to demonstrate authentic personal engagement more effectively. You should discuss the topic with your teacher before you put too much time and effort into writing your exploration. **We will spend more time with first week of school and the week before Fall Break looking at examples and choosing topics.**

These questions may help you to find a topic for your exploration:

- What areas of the syllabus am I enjoying the most?
- What areas of the syllabus am I performing best in?
- Which mathematical skills are my strengths?
- Do I prefer pure mathematics, or applied mathematics and modelling?
- Have I discovered, either through reading or the media, mathematical areas outside of the syllabus that I find interesting?
- What career do I eventually want to enter, and what mathematics is important in this field?
- What are my own special interests or hobbies? Where is the mathematics in these areas?

These questions will help you decide if your chosen topic is suitable.

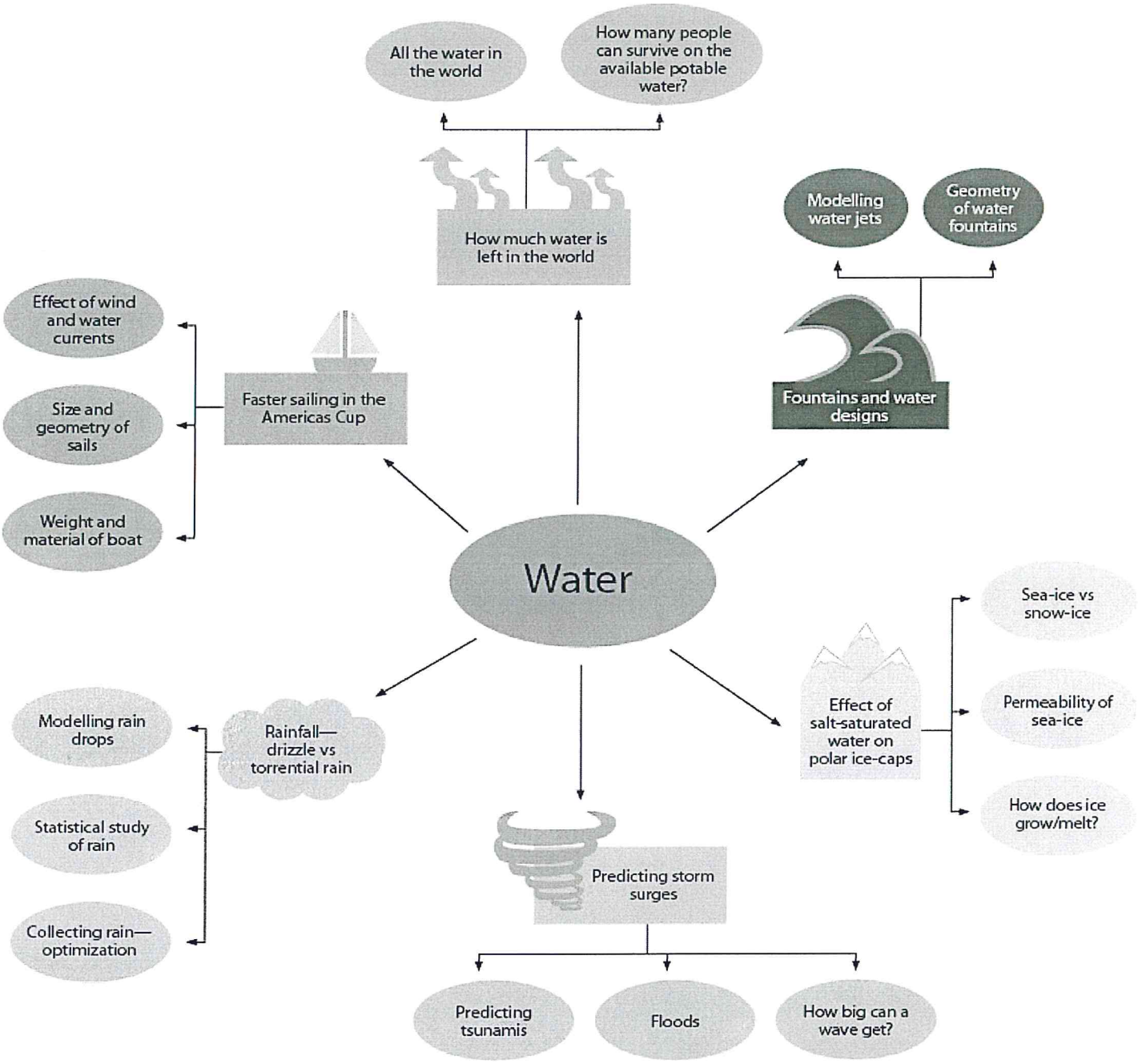
- What areas of mathematics are contained in my topic?
- Which of these areas are accessible to me or are part of the syllabus?
- Is there mathematics outside the syllabus that I would have to learn in order to complete the exploration successfully? Am I capable of doing this?
- Can I show personal engagement in my topic, and how?
- Can I limit my work to the recommended length of 6 to 12 pages if I choose this topic?

You may sometimes find it difficult to know where to start with a task as open-ended as this. While it is hoped that you will appreciate the richness of opportunities for mathematical exploration, it may sometimes be useful to be provided by a stimulus as a means of helping you to get started on your explorations.

Possible stimuli that could be given include:

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

The mind map below illustrates how, starting with the stimulus "water", some possible foci for a mathematical exploration could be generated.



Sites to explore for potential topics and examples…

http://www.dpcdsb.org/NR/rdonlyres/FE43C622-9FA0-4385-8E19-0C539513295E/133918/ListofPotentialTopicsfortheExploration1.pdf

http://dpmathematicssl.weebly.com/exploration.html

http://home.earthlink.net/~bhsfrisbie/Precalc/ExplorationsSites.html

http://ibmathsresources.com/2013/09/03/maths-ia-exploration-topics/

Sample Paper Topics Aligned with IB Math Curriculum

Unit 1: Functions • Define functions graphically, algebraically, numerically and verbally • Types of functions and defining domain & range • Dilation and translation of functions and graphs • Composition of Functions • Inverse of a function • Even/odd functions	• The development of functions [Rene Descartes (France), Gottfried Wilhelm Leibniz (Germany) and Leonhard Euler (Switzerland).] • Shifting supply and demand curves • Kinematics • Hardy-Weinberg equation • The birth of complex numbers
Unit 2: Exponential Functions and Logarithms • Shapes of functions • Identifying functions graphically and numerically • Properties of logarithms • Logarithm equations • Logarithm functions • Logistic functions for restrained growth	• Calculation of pH • Banking (i.e. compound interest) • Scientific models (i.e. growth and decay) • Earthquakes (i.e. the Richter Scale) • The history of logarithms and Napier's rods • Fermat's belief for a formula for prime numbers and Euler's proof that he was wrong • The mathematics of music
Unit 3: Sequences and Series • Definition of Sequences and Series • Arithmetic, geometric and other sequences • Series and partial sums • Binomial theorem	• Compound interest and population growth • Fibonacci sequence • Discovery of the golden ratio • Koche's snowflake (history and limits of areas and permiters) • Sierpinski's gadget • Mendelbrot set • Canter and his research with infinity • Euler and the number e • Perfect numbers • How can fractals be used to measure coastlines? • Chaos theory • Julia Sets • Graphical iterations • Math and the Mona Lisa
Unit 4: Period Function and Right Triangle Trig • Measurement of rotation • Sine and cosine function • Values of sine, cosine, tangent, cotangent, secant, cosecant • Inverse trigonometric functions	• History of the derivation/calculation of pi • History of the derivation of Pythagorean theorem • Simple harmonic motion

Unit 5: Graphing Period Functions • Cycle of sinusoidal graphs • Finding equations by looking at graphs • Graphs of tangent functions • Radian measures of angles • Sector, segments, areas and perimeters • Circular functions • Solving trig functions graphically and algebraically	• Tides • Turning of wheels • Modeling rock formations
Unit 6: Identities • Pythagorean, Reciprocal and Quotient properties • Identities and algebraic transformations of identities • Double angle identity and Quadratic Trigonometric Equations	• The witch of agnesi curve and its corresponding derivation
Unit 7: Non-right angle triangle trig • Oblique triangles • Law of sine and cosine • Area of triangles	• Aircraft heading to counter wind • Land surveying
Unit 8: Descriptive Statistics • Displaying data • Measure of center • Measure of spread • Percentiles • Variance and standard deviation	• Psychology studies • Advertising/misleading statistics • Biology studies
Unit 9/10: Probability • Experimental probabilities • Sample spaces • Independent and dependent variables • Multiplication rule • Conditional probabilities • Binomial probabilities • Discrete and continuous random variables • Expected values	• Experiments • Medical testing (i.e. false positives) • Gambling • Measuring risk • Monte Carlo simulations • Pascals' Triangle • DeMorgan's laws • Simpson's Paradox • How are insurance rates computed?
Unit 11: Normal Distribution • Normal curve • Empirical Rule • Z-scores • Probabilities of normal distribution • Inverse probability	• Feeding farm animals, amounts determined based on weights • Business decisions made based on a normal curve • The history, development and significance of the t-distribution • Genetics and cancer risk assessment
Unit 12: Regression and Linear fit • Least squares line • Residuals • Correlation coefficient • Non-linear regression	• Estimations for businesses • Economics • Psychology • Measuring success on standardized tests in education • The history and development of the least squares regression line