

Possible topics for Math Exploration ([many are also applicable to ACS Yr 4 IP coursework](#))

I shall guide you closely the Mathematics behind for most of the topics listed below. Don't worry that there are students before you did topics that you are interested. Everyone present the Mathematics behind differently and everyone focus on different applications that are close to their hearts. I'll also add on new stuff I found out recently to add colour to your work. We are together, so you just need to be committed and we shall pass with flying colours.

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1	Law of 72 (number of years to double one time investment amount).
2	Black hole numbers (for 2, 3, 4, 5, ... digits)
3	Using Pascal triangle to find powers of 11 and extend to find powers of 111, 1111, 11 111, ... What are all the interesting formulas in Pascal triangles? How to generate Fibonacci sequence from Pascal triangles? Let's prove all the formulas! Why do binomial coefficients coincide with numbers in Pascal triangles? I'll also share how I use Binomial theorem to save more than S\$4000 for my wedding dinner!
4	Using AP / GP to maximize retirement fund with just CPF contribution and without increasing any risk. Plan for retirement even before your start working!
5	How to find cube root of 2 with a non-scientific calculator with a square root function.
6	The graphical representation of a 2x2 matrix!
7	Continued fraction to approximate irrational numbers like π , square root of non-perfect numbers, golden ratio,...
8	Where does synthetic division come from? How to perform synthetic division for polynomial divisor of degree more than 1?
9	Explain transformation of graphs by using transformation of axes.
10	Investigation of divisibility by 2,3,4,5,6,7,8,9,10,11,12, ... Explain why the difference between 2 numbers with their digits rearranged is always divisible by 9? E.g. $327 - 273 = 54$
11	History of logarithm and its' application e.g. Richter scale and pH value. Why are logarithm laws true? Prove it! Why are logarithm and argument formulas similar?
12	What is the alternative way to describe a circle? Use complex numbers to discuss these 2 different ways of describing a circle.
13	Given the perimeter of a triangle, prove that the maximum area occurs when it's an equilateral triangle. Extend to cyclic quadrilateral.
14	Pythagorean triplets. Derive the Pythagorean triplet generator using 2 parameters and show how it can be reduced to 1 parameter and use different approach to derive the same generator with 1 parameter.
15	If $\deg(P(x)) = 2$ and $\deg(Q(x)) = 1$, $f(x) = \frac{P(x)}{Q(x)}$, discuss the interesting phenomenon when there are 2 stationary points with or without using Calculus.
16	Using theory learnt in quadratic functions, find the foot of perpendicular of a point from a given line. Show that this method works for locating the 2 points on skew lines such that the distance between these 2 skew lines is the distance between these 2 points.
17	We learn completing the square and prove the formula for finding roots of a quadratic equation. How about exploring completing the cube to solve cubic equations?
18	How to solve a rational polynomial inequality $\frac{P(x)}{Q(x)} \leq 0$ where $P(x)$ and $Q(x)$ are completely factorized?
19	Prove Pythagoras Theorem (implication on both ways) and show how to construct $\sqrt{\frac{p}{q}}$ where both p and q are positive integers. Prove the law of reflection by using Pythagoras theorem.
20	We learn to prove congruent triangles there are only 4 reasons S.S.S, S.A.S, A.A.S and R.H.S, is that true? Explain geometrically when and why does ambiguous triangles arise? (note that this topic is only SL math standard)
21	An easier way to derive the regression line and r-value. Collect any 2 sets of data to investigate their linear relationships. We can extend to perform a hypothesis test on the r-value. (note that this is highly recommended for ALL SL Math students).
22	Investigate the feasibility of Singapore with a population of 6.9 million. Do we have enough space to build so many homes and jobs for so many people? What is the population size that will make Singapore self-sustain? Use Math modelling to answer the above questions