**Personal Statement**

This essay serves as your introduction to the Admissions Committee, and provides an opportunity for you to discuss your interest in mathematics and your goals for your participation in the Ross Program. For your Personal Statement, please write an essay discussing the following questions and related topics.

* What aspect of mathematics draws your interest and attention? Are you interested in math for its own sake? For the thrill of solving puzzling problems? Or because math has important applications to other fields?
* Do you have some strong academic interests in addition to math? For instance, are you intensively studying physics? Or economics? Are you serious about Chinese literature, paleontology, or modern dance?
* What do you hope to gain by attending this challenging summer program?
* How do you like to spend your time?
* What are your hobbies or interests outside of school?

“All is number,” says Pythagoras.

The wisdom in this saying manifests itself in our lives. To me, life could be interpreted as a mathematical function, simple at first glance but full of the unknown in hindsight. Since childhood, I’ve loved to render difficult things simple, a skill I obtained from playing math puzzles. Over time, mathematical thinking has become an indispensable part of who I am.

Assume both “a” and “b” are greater than 1,

then consider the function: y = a^x + b.

This precision, a sense that outcomes are predetermined, may have slackened my mind, making myself content; however, the succinct, elegant mathematical function has also inspired me to look for new possibilities.

**1. “a” never changes the shape the graph**

As a constant, “a” is the unwavering part of my identity.

Starting with piles of Sudoku books that I discovered at mother’s bookshelf, I became obsessed with all sorts of puzzles and card games. That was when I began to attend every possible after-school math class within my reach. They were admittedly tedious, but they took me into the depths of every single theorem, preparing me for my future study of advanced mathematics.

Soon I became unsatisfied. Maybe because of the GIF of homeomorphism I saw somewhere on the Internet, or perhaps the linear transformation video I saw the other day, I believed that there must be something more about mathematics. I searched online for interesting content: first the concept of infinity, then group theory, topology, graph theory - you name it. All those mysterious symbols and graphs evoked my inner sense of eagerness.

The world of math has become my temple, my mosque, my church; it’s where I feel the uttermost peace, where I find the loyalist comrades, where I obtain the purest joy and where I met my deepest thought. It’s a world that challenges as well as entertains me more than anything else.

**2. “x” is what I see, hear, and experience …**

In my world, “x” is a variable, always larger than 1.

During the past ten years, my parents have encouraged and supported me to travel around the world with the money we gathered by cutting back on our other expenses. Though meeting with language barriers, sleeping in tents and hitting the rough roads, I’ve traveled across New Zealand, Iceland, Sri Lanka, Kenya, and numerous other wonderlands.

During one of my journeys, I encountered United World College and become captivated by its unique educational philosophy. Since my attendance at UWC, I’ve met people from all over the world, even some places I’ve never heard of. I felt unsettled by the upheavals in my Afghan roommate’s country. I greeted my environmentalist-friends amid their campaigns, and I accepted my Muslim friend’s invitation to join an LGBTQ rally. From experiences like these, I gained familiarity with different religions, cultures, and values.

Besides the math world and the human world, I’ve paid equivalent attention to the natural one, and the same overwhelming sense of curiosity drives me to explore. By monitoring and examining the marine species along the coast of Race Rocks Islands, I’ve become aware of the worse marine environmental problems our generation is facing: marine plastics, ocean acidification, biodiversity loss and so on. They become so close and so real when I witness, with my own eyes, the sea lions entangled by the fishing lines on the beach.

I endure the freezing winter Pacific Ocean water in order to monitor the underwater biodiversity and help with ocean cleanup.

Living on a 0.5km^2 island for a week without fresh water and electricity, I woke up every morning with the roar of California sea lions. I watched the travel of humpbacks from inside the lighthouse. Without proper toilets or bed, I came to better understand the real aspects of nature and wilderness instead of the romanticized images that prevail.

**3. With “b,”** “**y” is who I will become.**

a^x is who I am, albeit I am looking for such a “b” that would help me go further in my journey of math. The Ross Program can be such a “b.”

In my expedition in the world of mathematics, I’m also thrilled by the diversity and interconnection math has with the rest of the world. I try to relate everything in the world with mathematics: all information can be stored as numbers in computers; all tangible, as well as higher-dimensional objects, can be described by functions. Math is such a beautiful language that helps me dissect myself and the surrounding world. Feeling hot can be expressed by regression (in sports), Bayes’ formula can be used for testing cancer treatment’s effectiveness (in medicine), wise decisions can be made based on the expectation (in the lottery), and numbers can show the faults of an electoral system (in politics). If I want to figure out what Quantum mechanics is, the easiest way is to draw inspirations from uncertainty, wave function collapse, Schrodinger equation, and Quantum Bayesian model.

At the same time, I am yearning for the purity of abstraction in math itself, and I want a summer for math only. With no distraction, Ross Program will provide me with a mathematical haven where I can “swim” at ease. By investigating into number theory - one of the purest areas in math - I will boost my understanding of math from its most basic level and trace its development over history. I cannot wait to set foot on the road of number theory on my own, experience all the mountains and seas that former mathematicians have conquered, get a glimpse into their way of mathematical thinking, and predict the future advancement of mathematics at its explosive velocity.

In my world, mathematics is everything, from 3,500 meters below the surface of the ocean to 10 billion light-years into space. If admitted to the Ross Program, I believe it would empower me to further integrate my exploration of math, human and nature.

**1. Problems**

**What is an interesting mathematical problem you have worked on? Recall a problem that you spent some time thinking about. Carefully state the problem. Describe the work you have done on it.**

“One, two, three, …” I was trying to draw out the complete exchange graph of Mobius stripe with marked points, wondering whether it was possible to calculate the number of all triangulations. Easy as I initially thought it would be, it turned out to be complicated and overwhelming. Frustrated, I turned to Cluster Algebra in the hope of viewing this intriguing problem from a different perspective. I drew their exchange graphs and cluster complexes and represented them in double cover, snake graph ...

I also tried to use brute force up to 4 marked points, but the result turned out to be not ideal. When I was nearly on the verge of emotional collapse, my mentor came up with an idea, “Maybe we can look at this from a combinatorics perspective, and it might have something to do with Catalan number.” I was suddenly enlightened. In every triangulation, each boundary edge is part of only one triangle. Inspired by this idea, we soon summarized three cases in which two arcs could divide the non-orientable surface. For the orientable part, the area without the crosscap, we directly apply the Catalan number to count the number of triangulations. For the non-orientable part, the area with the crosscap, we defined the number of triangulations recursively. By adding the three cases, we finally got a formula to solve our confusion.

However, the answer we got was recursively defined, and there was no simpler function to be found - even wolfram alpha cannot interpret a recursive formula with that complexity. I have to propose a new, simple formula, but its proof, either through the simplification of the recursive definition or by thinking from another angle, still awaits me to explore.

Logic and rigor have always been the inherent charm of mathematics, but what is more attractive to me is the unexpectedness in mathematics. It seems to be waiting for me right around the corner, guiding me to link everything together but think out of the box at the same time.

**2. Projects**

**Have you worked on some interesting mathematical projects? If so, what were the topics? For the project you enjoyed the most: How much time did you spend on it? Were you working alone, guided by a mentor, or as part of a team? What benefits do you feel you gained from doing that work?**

Cooperative projects: The unistructurality of quasi-cluster algebra; The number of triangulations on a Mobius stripe.

Individual Projects: Tensor Calculus and Kaluza Theory; Mathematical Modeling of Local Climate Change.

I enjoyed the process of proving the unistructurality of quasi-cluster algebras. After reading some literature of cluster algebras, I began to explore what will happen if a cluster algebra is on a non-orientable surface like a Mobius stripe, collaborating with a Ph.D. mentor from the University of Quebec at Montreal. Will the unistructurality still hold?

To prove the unistructurality, I need to prove first a cluster algebra does not depend on the particular triangulation. Then I could get two important formulas from the positivity, which helps me prove the unistructurality of quasi-cluster algebras. However, when I shared my idea with my mentor, she questioned my proof. It failed to prove positivity holds for quasi-cluster algebra. And my proof, starting from lemma, was just based on the validity of positivity. Although we were pretty sure that positivity should be true for quasi-cluster algebra, neither of us had a clue to prove it.

Then, I read a lot of literature about quasi-cluster algebras, but there wasn’t much reliable information given that this field is very new. After two months of stagnation, my mentor excitedly showed me a newly published article, which proves the positivity for quasi-cluster algebras. The author is so smart to adopt methods that we’ve never thought about. Snake graphs and lamentation. Amazed at the fact that someone in the world shares the same passion for a math problem, I contacted the author, unhesitatingly. He was so glad to help us with further investigation on the basis.

Through my project experience, I’ve got a taste of mathematical research. But, much to my surprise, I’ve witnessed a huge mathematical knowledge system’s being built up at an explosive rate with intellectuals specializing in different topics from over the world. As the most direct demonstration of the constant pursuit of intellectual challenges, math never fails to flood me with awe.

**3. Other programs**

**Have you participated in academic programs outside of school? This might include another summer math camp, a local Math Club, or a Math Circle at some nearby college. What sorts of math activities were involved? Did you enjoy those experiences?**

“Mathematics all day, every day.”

This was my morale chant at Canada/USA Mathcamp last summer. I spent more than 12 hours a day swimming in the ocean of mathematics and exposed myself to college-level mathematics for four consecutive weeks, including but not limited to Cluster Algebra, Knot Theory, Non-Euclidean Geometry, Root System, Morse Theory. Often, my roommate fell into sleep with her Poincare Formula worksheet; I woke up where she left off. The first second we looked at each other, we would begin to discuss our new ideas. I walked with mathematics, showered with mathematics, and ultimately lived with mathematics.

Math existed around me in all sorts of interesting forms. I joined to adapt songs in mathematical language and stayed up all night playing Board games and Math puzzle hunt. What had long been treated oddly in my previous life had finally become even: my peers joined in instead of watching bewildered while I constructed all sorts of triangles with my hands at meals.

“How to prove two plus two equals four?” I was lying in my dorm back in Victoria, gazing at the floor covered by scratch paper, with this single straightforward yet difficult problem stuck in my mind in the last two days. I always carry the spirit of my Mathcamp experience with me. In this hi-tech age, the simple trio of paper, pen, and determination is still capable of surprising insight. And along the way, it feels good to be confused and satisfying to tackle the confusion.

“All day, every day.”

Math exists around me in all kinds of interesting forms, we adapted songs in mathematical language, and stayed up all night playing Board games and Math puzzle hunt.

**4. Competitions**

**Have you recently participated in some math competitions? Which ones? Did you do well on them? How do your math contest experiences (both preparing for and participating in contests), compare with math courses you have taken in high school or in other venues?**

Last month I got invited to visit the University of British Colombia because of my excellent performance in the Canadian Open Mathematics Challenge. It turned out that I got an Honor Award at the 11th-grade level. Recently, I also received a “Meritorious” award for HiMCM that I paid efforts for with other three friends last November.

In January, I participated in the MIT puzzle hunt online, which was the most fun competition I’ve ever attended. I’d rather call it less a competition than a gathering where a group of math lovers solved interesting problems together. It didn’t matter whether who win or lose. In fact, the math shouldn’t be competitions which are used to evaluate computing ability with limited time.

Math is more about creativity and faith. When I prepare for proving a mathematical formula, I need to know the logic behind the proofs first and conceive what mathematical tools I’m going to use and how I’ll use them. In most cases, it does require an answer or a statement; however, what counts more is the logic behind and how I get it. Only when I slow down, deliberate every detail in a problem can I fully appreciate the beauty of mathematics.

Other Math Honors and Awards:

1) Meritorious Award, 22nd Annual High School Mathematical Contest in Modeling (HiMCM), 02/2020;

2) Honor Roll in BC, the Canadian Open Mathematics Challenge, qualified for attending Canadian Mathematical Olympiad (CMO), 11/2019;

3) Top 5%, Euclid Contest, The CENTER for EDUCATION in MATHEMATICS and COMPUTING, University of Waterloo, 05/2019;

4) First Prize (China), Math League, qualified for US Final (at Stanford) and its Math Camp (co-held by the Departments of Mathematics of Princeton University, Columbia University, and Williams College), 2018;

5) Second Prize, Jiangsu Junior High School Mathematics Competition, 2017;

6) Second Place (Global Final), The Berkeley Mini Math Tournament (BmMT), 2017.

**5. Books and websites**

**What have you read recently about mathematics? Which math books are your favorites? What parts of them were most enjoyable or interesting to you? What interesting mathematical websites have you visited in the past year? What aspects of math have you learned by reading the material on those sites?**

**Books:**

1) What Is Mathematics - *Richard Courant & Herbert Robbins*

2) Geometry of Surfaces - *John Stillwell*

3) Studies on Paradoxes - *Bo Chen*

4) The Knot Book- *Colin Adams*

5) Mathematics and Philosophy - *Jingzhong Zhang* (The book enumerates how mathematical tools are used to solve questions of philosophical significance, and discusses different philosophical perspectives of mathematics. Numerous examples in the book inspire me to perceive math from a brand new angle - what it is, how it was born and developed.)

6) Mathematics + Art: A Cultural History - *Lynn Gamwell*

7) Gödel, Escher, Bach: An Eternal Golden Braid - *Douglas Hofstadter* (Gödel’s incompleteness theorems, Escher’s paradoxical painting style, and Bach’s fugue musical compositions inspire me to think beyond dualism rather than endlessly examine the complete opposition between truth and paradox, formalism and informalism, the human brain and artificial intelligence.)

**Websites:**

1) Wolfram MathWorld (Fabulous math encyclopedia where I’ve learned mathematical equations and theories I encounter and have access to an abundant resource for research.)

2) Brilliant (The online community empowers me to build quantitative skills in math, science, and computer science with fun and challenging interactive explorations.)

3) MIT OpenCourseWare (An inspiring source for me to explore mathematics at a college-level, for example, root system in a Euclidean space, Young Tableaux in the course of combinatorics, and introduction into the representation theory.)

4) Expii (Learn math creatively.)

5) Global Math Project

6) Association for Women in Mathematics (AWM)

7) Art of Problem Solving (AoPS is a cornucopia where I challenge myself with various tough mathematical problems.)

**6. Future goals**

**What do you plan to major in at college? What are your career goals? Do you feel “driven” toward one type of work? (Like an academic career in math, astronomy, or economics? Or a career in finance? etc.) Or will you take a variety of courses in college and see what areas seem most interesting?**

“The water waves shone in aqua, the light pours down through the traditional-style railings…” It was a model we built with recycled materials for a complex on our campus. The waves were tailored from discarded Sprite bottles, and the buildings were made of used cardboard.

The complex was designed by a disciple of Ieoh Ming Pei. Inspiration coming from classical Chinese gardens, it not only reserves the slanting roofs and enclosed courtyards but also what I call “mooring in space.”

During my childhood, I liked to wander around Suzhou’s historic gardens. There’s one with a pond and a bridge at one end. While viewed from a certain angle, the pond extends beyond the bridge and into the bamboo forest. Everything then builds upon one another visually. When I look through a floral window or walk along an ambulatory, it gives a sense of infinity for the path winding into jungles.

I’d liken these multi-dimensional garden architectures to the polytopes I learned in mathematics - objects travel in four-dimension. Each part of the garden seems to be distinct and separate, but when viewed from the right angle, they become such a vibrant entirety. The parts travel, tangle, and scatter around. They interact in such a way that even could be interpreted by most advanced mathematical theory. But this architectural art goes far beyond the logic, turning mathematics from the rational to the perceptual, from the regular to the non-linear.

I plan to study mathematics and architecture at college, aspiring to be a designer who will mathematically interpret the architectural idea.

**Collaboration**

**When you work on hard math problems do you usually work alone? Or with a group of friends? Reminder: when you work on the Ross Application Problems, please be sure to work by yourself.**

I don’t mind working alone, and in fact, I usually work on math problems alone. Sometimes I enjoy this kind of loneliness since I could not find a peer as passionate about math as I am in my school. I’ve been accustomed to spending hours thinking about a problem myself before turning to my math teacher or senior students for help. This struggling process of figuring out a tough math problem can be likened to that of being suffocated under the water. Only after I learned to swim and can float on the surface of the water can I learn to appreciate the beauty of mathematics. Struggle and progress are twin brothers.

In some cases, however, that is not the entire truth. When investigating quasi-cluster algebra, I’d prefer to seek collaborations with other math friends. During the process of proving the number of triangulations, I discussed a lot with my mentor and like-minded peer via video meetings. Exchange with other math lovers, especially those who are adept in various fields of mathematics, could be extremely rewarding because *the fire burns high when everybody adds wood to it*. Collaboration can offer new insights and a broader horizon into a difficult yet intriguing problem. It is one of the reasons why I am so looking forward to attending the Ross Program, which will not only open for me the window of number theory but also provide a community to meet a group of young scholars sharing the same enthusiasm about mathematics.

**Other coursework**

**Have you taken math courses outside of the standard high school curriculum? Those courses could have been at a local college, in a residential math program, from an educational website, etc.**

Most of my acquisition of mathematical knowledge comes from outside of my school curriculum. I still remember the first time I saw a video from 3Blue1Brown, where I run into Linear Algebra and sensed the study of mathematics can not only be realized step by step following my school curriculum. After searching for mathematics courses from Coursera, edX, and Socratica Studios, I decided to self-study high school mathematics.

Mathcamp has once again changed my perception of math learning. The vast majority of advanced mathematical theories can be acquired in a basic way. Math is diverse; different topics and theories in fields can be interconnected. I began to understand the properties of linear transformation I met within the 3Blue1Brown videos. I was no longer amazed by the Lagrange theorem for its connecting number theory with group theory. I engaged myself to study how linear algebra can be used in the area of algebraic topology to prove the famous Euler-Poincare formula.

Enchanted by this charming formula in modern mathematics, I enrolled in an online course of algebraic geometry instructed by Visiting Professor Sheshmani at Harvard University. However, studying with a group of undergraduates, I realized I still have a lot to learn before jumping into advanced fields. Before entering an intense war, I need to do more strenuous physical training. Therefore, at the Ross Program, I look forward to building up further on my math knowledge system and exercising my “muscles” through a sea of problem sets.

**Being away from home**

**Are you eager to spend five or six weeks away from home, with no distractions from computers or video games or smart phones, focusing all of your energies on one narrow area of**

**mathematics? Ross students live in a college dormitory, with no access to televisions, computers, or electronic games. Most of their waking hours are spent working on challenging math problems. Does this intensity and focus appeal to you?**

I woke up with the howling of sea animals. It took a while before I realized being in an ecological reserve. It was still dark outside. I opened the door. The peculiar smell of coastal creatures hit me. Then, I walked out. Living on Race Rocks Islands for a week, I’d been used to a lot of things: no shower, frozen food, limited electricity… I only looked forward to the sunrise and sunset every day. “The demands of mankind are unlimited,” I started to reflect on what my economics teacher said in class. I’d like to get lost on the island, where I have little but lack nothing. Self-sufficiency is all I need, just like how it was since the dawn of mankind.

This time, I want to carry the same pureness to the Ross Program.

I’m excited about immersing myself in mathematics. Working on a math problem for an hour or two at night has become a daily routine for me. There are times when I’m so fixated on a problem that I’ll think about it for most of the evening, even when I’m brushing my teeth or lying on my bed before falling asleep. However, with patience and accumulation of information, I’ll piece together the clues to find a solution. I am expecting to have one period of time when I can totally focus myself on mathematics to gain momentum, to enjoy the process, and to fully research and delve into this topic.

Therefore, the Ross Program is such a wonderful opportunity for me to enjoy the purity of mathematics. I will study with math lovers from all over the world, exchange thoughts with counselors and professors of strong math backgrounds, and work on piles of problem sets for the whole day without worrying about any external distraction.