

**2015 SIEMENS COMPETITION IN MATH, SCIENCE & TECHNOLOGY
Regional Finalists – Massachusetts Institute of Technology**



NAME: RYAN CATALANO

SCHOOL: North Brunswick Township High School, North Brunswick, N.J.

YEAR: Senior

HOMETOWN: North Brunswick, N.J.

PROJECT: Characteristics of a 2-Grid Inertial Electrostatic Confinement (IEC) Fusion Device Operating at High Pressure

FIELD: Physics

MENTOR: Dr. Matthew Lucia, Doctoral Candidate and Research Scientist, Princeton Plasma Physics Laboratory

"I am most interested in being a part of fusion development and research."

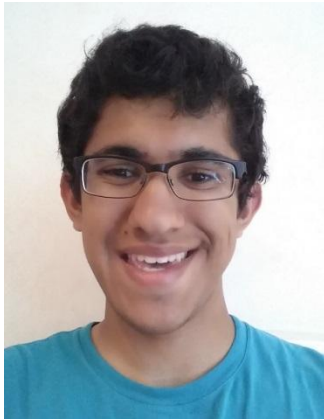
Ryan Catalano's project characterizes an Inertial Electrostatic Confinement (IEC) device that operates at high pressure and has a short electrode separation distance. His work contributes to an overall understanding of how IEC devices operate, and the development of better neutron generators and future fusion energy sources. He was first inspired to pursue fusion research after reading an article in *Popular Science* about the International Thermonuclear Experimental Reactor (ITER).

Ryan's favorite part about physics is that it challenges him to think critically. He also fostered his passion for physics when he interned for Dr. Robert Kaita, a Principal Research Physicist for Princeton's Plasma Physics Laboratory working on the LTX and NSTX fusion projects. To date, his proudest accomplishment is achieving his first successful fusion on April 11, 2015.

For his first science project, Ryan made a homemade hovercraft – powered by his dad's leaf blower. When he and a friend both tried to ride it, it broke - so in hindsight, Ryan would have used thicker plastic and a cordless leaf blower.

Ryan aspires to be a nuclear engineer and anticipates majoring in the field in college. Ryan also won his school's science award as a first-year and sophomore.

Outside of the lab, Ryan was a team member on a two-week church mission trip to the Bulembu Orphanage in Swaziland. He has also volunteered for "Love Your Neighbor," a community church outreach program where he helped local senior citizens with home projects. Ryan is also a black belt in Taekwondo and enjoys water sports.



NAME: MILIND JAGOTA

SCHOOL: Liberty High School, Bethlehem, Pa.

YEAR: Senior

HOMETOWN: Bethlehem, Pa.

**PROJECT: Computational Study of Random Nanowire Networks:
Optimization of Conductivity through Orientation**

FIELD: Materials Science

**MENTORS: Dr. Nelson Tansu, Daniel E. '39 and Patricia M. Smith Endowed
Chair Professor; Director, Center for Photonics and Nanoelectronics
(CPN), Lehigh University**

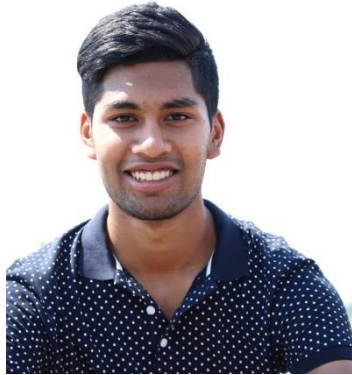
“As I saw smartphones and tablets becoming ubiquitous in daily life, I began to wonder about the touch screen technology that made them possible.”

Milind Jagota’s project identifies a way to increase the performance of an electronic material. The material could be used in electronic devices from solar panels to smartphones, and increasing its performance can foster innovation in those areas. As he saw smartphones and tablets becoming ubiquitous in daily life, Milind began to wonder about the “magic” behind the touch screen technology that made them possible. His research made apparent the critical role of transparent conductors in touchscreens and their broader use case scenarios.

Far more advanced than his early memories of rock candy crystal experiments, Milind pursued this project because he has a passion for electronics and the potential for Indium Tin Oxide to have a broad societal impact. His favorite subjects in school are physics and computer science. Milind’s favorite part about STEM is the interdisciplinary exchange of ideas between historically distinct fields.

Milind aspires to be an electronics engineer and is interested in both consumer electronics and medical technology. To date, his proudest accomplishments are publishing this research project in the Nature Publishing Group’s Scientific Reports Journal, as well as participating in the Pennsylvania Governor’s School for the Sciences. Milind anticipates majoring in engineering physics or electrical engineering in college. He is interested in attending Stanford University, the Massachusetts Institute of Technology, Cornell University, the University of Pennsylvania, Princeton University, Columbia University, Northwestern University or Lehigh University.

Outside of the classroom, Milind plays varsity tennis, volunteers at the DaVinci Science Center and is a member of the Liberty High School Marching Band. If he could meet any historical figure, it would be Aristotle because of the philosopher’s far-reaching interdisciplinary impact on ideas even into the 21st century.



NAME: KUNAL SINGH

SCHOOL: High Technology High School, Lincroft, N.J.

YEAR: Senior

HOMETOWN: Holmdel, N.J.

PROJECT: Classification of Subtle Morphological Features for Individual Nuclei in Stained Glioma Tissue Slides

FIELD: Computer Science

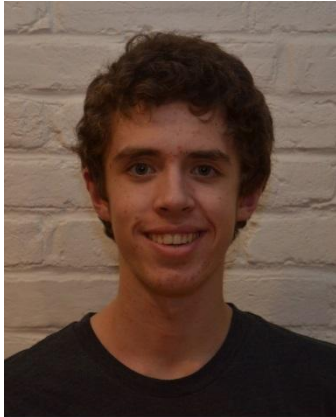
MENTOR: Dr. Dimitris Samaras, Associate Professor of Computer Science, Stony Brook University

"I found a more comprehensive way to predict the characteristics of individual nuclei in stained glioma (malignant brain tumors) tissues for more efficient and accurate diagnosis of gliomas."

Kunal Singh pursued this project because he is interested in the application of computational methods to solve complex problems. He further explored this area as a Simons Summer Research Program participant. Kunal hopes that with his project, the world can have a more efficient and accurate diagnosis of gliomas. Kunal has previously earned a Young Scholar Award for a paper on analyzing tweets from breast cancer patients at the 2015 Social Media and Society Conference.

Kunal's parents first piqued his interest in math and science by teaching him how everyday things work. He aspires to be a researcher in a computer science-based interdisciplinary area. Outside of the classroom, Kunal serves as Student Council President at the Chhandayan School of Music, volunteers at Newark Beth Israel Medical Center and plays on Holmdel High School's tennis team. He plays the Tabla, an Indian percussion instrument.

Kunal's hero is Muhammad Yunus, for his work in pioneering microfinance in developing countries and if he could speak with anyone from history, it would be Mahatma Gandhi – who serves as an everyday inspiration for Kunal.



NAME: KONRAD URBAN

SCHOOL: Fox Chapel Area High School, Pittsburgh, Pa.

YEAR: Senior

HOMETOWN: Pittsburgh, Pa.

PROJECT: Improving Quality of Service Protocols With Genetic Multi-Swarm Particle Swarm Optimization Algorithm

FIELD: Computer Science

MENTOR: N/A

"I designed a biologically-inspired system to improve the speed and quality of computer communications."

Konrad Urban's research could be applied to high-performance systems, like military networks and gaming platforms, improving the speed and quality of communications within those systems. He believes that exposing students to the applications of technology, especially in computational domains like robotics or codes that interact with the internet is an important factor in getting kids interested in pursuing STEM fields.

Konrad has previously been listed as a coauthor on a Carnegie Mellon University robotics paper, which was accepted to the Institute of Electrical and Electronics Engineers (IEEE) Conference on Robotics and Automation. He also started a robotics class for middle school students and serves as a mentor for their robotics team. His favorite subject in school is physics, and he anticipates majoring in Computer Science in college. He is currently considering the Georgia Institute of Technology, the University of Michigan, the University of Illinois, Stanford University, the Massachusetts Institute of Technology, the University of California: Berkeley, Carnegie Mellon University, the University of Texas at Austin, the California Institute of Technology, Rice University, the University of Washington and Northwestern University.

Konrad has participated on a summer swim team since he was in elementary school. To expedite the lineup-making process for each meet, in which swimmers are assigned events in which to participate – Konrad designed software to generate swim meet lineups and tried to determine if his software was more effective than "conventional wisdom." Konrad also participates in Ambassador Orchestra, a high school service-based honors orchestra and runs cross country.



NAME: ZIHENG “TONY” WANG

SCHOOL: St. Paul’s School, Concord, N.H.

YEAR: Senior

HOMETOWN: Shanghai, China

PROJECT: High Throughput Drug Design by a Novel Grid-based Computational Method

FIELD: Chemistry

MENTOR: Dr. Carlos Simmerling, Professor of Chemistry and Associate Director of the Louis and Beatrice Laufer Center for Physical and Quantitative Biology, State University of New York at Stony Brook

“I developed a new computational method that could massively accelerate the drug discovery pipeline.”

Tony Wang’s project could benefit the world with cheaper and more effective drugs by means of a new computational method for which there are currently no reference protocols. Tony has been interested in molecular dynamics and computational chemistry because computational research is not an equipment-intensive field. An autodidact in molecular dynamics, Tony used software like GROMACS and resources like Rescale and Amazon AWS to further his knowledge base and pursue his research.

Tony’s favorite class in school is his for-credit independent study project on breast cancer metastasis. It’s his favorite because he gets to work in his tissue culture lab, which he developed on his own behind a biology classroom.

Tony aspires to be a research institute director. Outside of the classroom, Tony participates in Nordic skiing, cross country running and also rows crew. He is also the captain of St. Paul’s math team and investment club.

If Tony could speak with anyone from history, he would tell Eve not to eat the apple.

TEAM COMPETITORS

EMILY CHENG, Methacton High School, Eagleville, Pa.

KELLY JIANG, Conestoga High School, Berwyn, Pa.

GERALD LIU, Methacton High School, Eagleville, Pa.

PROJECT: "Simultaneous Detection of Genetic and Epigenetic DNA Modifications by Targeted Next Generation Sequencing for Cancer Screening--Assay and Data Analysis Software Development for the Detection of Hepatocellular Carcinoma"

MENTOR: Ying-Hsiu Su, Principal Scientist, Blumberg Institute

"Our team developed a panel that includes DNA modifications for liver cancer, in addition to creating novel software that bypasses the data analysis bottleneck in next generation sequencing."

Emily, Kelly, and Gerald developed a panel of genetic and epigenetic DNA markers for the early detection of Hepatocellular Carcinoma, or cancer of the liver, and also created software to analyze the data to create accurate and specific diagnoses that bypasses the pre-existing data analysis bottleneck in next generation sequencing. With their project, the team looks to one day develop a panel to effectively screen for cancer in the early stages and prevent it from becoming life threatening for the many people affected around the world.



EMILY CHENG

YEAR: Junior

HOMETOWN: Lansdale, Pa.

Emily began participating in school science fairs after her mother convinced her in kindergarten, and has participated every year since. Emily's project inspiration came when a close family friend was diagnosed with Stage 4 liver cancer and passed away due to late detection. From there, Emily was determined to find ways to detect cancer early on and to identify other preventative measures. She was also inspired by previous Siemens competition national finalist Benjamin Song, who worked in the same lab as her.

Emily is a member of the National Honors Society and president of the French Club and Academic Decathlon Club. She also enjoys history and geography and learning about ancestry and human evolution, finding it important to understand different cultures, religions, and ethnicities. Outside the classroom, Emily is very involved in her church, plays piano for nursing homes in her free time, and enjoys playing tennis and soccer. Emily's career aspiration is to become an obstetrician.

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KELLY JIANG
YEAR: Junior
HOMETOWN: Wayne, Pa.

With this project, Kelly hopes to develop a way to detect cancer in the early stages and save lives through prevention. Kelly was inspired to study this area of research while working in her lab and observing a lack of successful methods to ensure the early detection of colon and liver cancer accurately and efficiently.

Kelly's favorite subject in school is history because she loves learning about how human interactions have changed over time and how it affects the world today. She also enjoys biology and chemistry because of the freedom and hands-on experience gained from her lab work. Kelly belongs to the National Honor Society and National Art Honor Society. Outside the classroom, Kelly is a varsity runner on her school cross country and track teams. One of her proudest moments was winning a cross country race. Kelly aspires to be a pediatrician.



GERALD LIU
YEAR: Junior
HOMETOWN: Audubon, Pa.

Gerald plays a vital role to the team with his background in bioinformatics and ability to efficiently analyze data. He was eager to pursue this project because it fit his interests revolving around biology and computers. Gerald was inspired by Ben Song and Jack Chen, former Siemens competition finalists, who work in the same lab as his team.

Like his teammates, Gerald's favorite subject in school is history. He enjoys reading about the past and sometimes finds it silly and entertaining. His earliest memories that piqued an interest in STEM were simple chemistry experiments he conducted at home as a kid. Gerald plans to apply to MIT, Stanford, Carnegie Mellon, and other universities as he gears up for his senior year. Gerald's hero is Bill Gates and

if he could meet any person in history, he would meet Aristotle to listen to him lecture and learn about the views of science and philosophy at the time.

Outside the classroom, Gerald likes to cook and play the violin and has played for the Philadelphia Sinfonia Players. At the 2008 Summer Olympics in Beijing, Michael Jordan sat behind Gerald and his family during a soccer match between Brazil and Argentina.

Team Competitors

THOMAS CHOI, Phillips Academy, Andover, Mass.

MATTHEW WANG, Princeton High School, Princeton, N.J.

PROJECT: An X-ray Search for Evidence of Black Hole Settling in the Galactic Center by Dynamical Friction

FIELD: Physics

MENTOR: Dr. Charles Hailey, Professor of Astrophysics at Pupin Hall, Columbia University

“STEM we feel is the answer to all the world's practical problems. The idea that STEM is THE solution makes the field all the more interesting.”

Thomas Choi and Matthew Wang’s team project found potential black hole candidates and provides the first observational evidence to support the dynamical friction theory that black hole binaries are clustering into the galactic center. This is one of the holy grails of galactic center astrophysicists, and their research signals impetus for future and professional astrophysicists to pursue the topic.



THOMAS CHOI

YEAR: Senior

HOMETOWN: Old Tappan, N.J.

Thomas’ first science project explored whether or not the movement in the upper body affected the speed of one’s underwater dolphin kick - a far cry from his research into astrophysics today. However, he’s been interested in math since primary school because as he sees it, when answering a question, there is no gray area and that has made the subject easy for him to grasp. Physics is another favorite subject of Thomas’s because he enjoys combining different concepts to solve one problem.

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Having a passion for math has inspired Thomas to choose engineering as a career path. He has applied to various universities with strong engineering programs including: Columbia University, University of Pennsylvania, MIT, Yale University, Duke University, Harvey Mudd College, and Tufts University.

Outside of his regular curriculum, Thomas is part of Phillips Academy's swimming and water polo teams. He is a peer tutor, president of the Modern Engineering Forum and a prefect, in which he mentored and led freshmen students.

Thomas has a great adoration for music, and he regularly plays the clarinet. One of Thomas's favorite memories is when he met half of his favorite band, Pentatonix, in line at an airport Starbucks.



MATTHEW WANG

YEAR: Sophomore

HOMETOWN: Princeton, NJ

With no background or previous experience in the realm of galactic center astrophysics, Matthew decided to pursue a project in this field. He has always been interested in the broader realm of physics and was inspired by a previous Siemens Competition winner who had a project focused around astrophysics.

Matthew's interest in STEM was first piqued by his parents and stoked in school, particularly during a biology class experiment when he saw how the different densities between oil and water resulted in separation. As he was, Matthew believes students at a young age should be exposed to STEM research projects since there is such a "real-world" component to the research.

As a sophomore, Matthew has begun thinking about college, possibly applying to Princeton University or Massachusetts Institute of Technology, and he hopes to one day become a professor.

Matthew is a member of the Princeton High School Track team, tutors in a variety of subjects, and plays the piano. Matthew had the opportunity to audition for the Golden Key Festival and performed at Carnegie Hall in New York City.

If Matthew could speak with one historical figure, he would choose Benjamin Franklin because he is an extraordinary scientist and one of the country's founding fathers.

Team Competitors

FENGYAO DING, Phillips Academy, Andover, Mass.

CRISTIAN GUTU, Joel Barlow High School, Redding, Conn.

PROJECT: Secret Room

FIELD: Computer Science

MENTOR: Albert Kwon, applied cryptography PhD student at MIT

“Many people worldwide - who rely on chat rooms to practice their human right - get executed.”

The Edward Snowden controversy inspired the ‘Secret Room’ project. Focused on the idea of allowing people to speak freely on controversial topics such as abuse, corruption, and oppression without being identified, killed or persecuted. Fengyao and Cristian developed a protocol that can be used for online chat rooms to enforce anonymity by spawning artificially intelligent users (AIs), thus guaranteeing freedom of speech. These AIs prevent cases when malicious users are the majority and "poll" data to identify potential honest users - a major flaw in previous protocols. The protocol is different from others because it allows hundreds of people to use it at the same time, greatly increasing anonymity for people reporting rape, unjust working conditions or noble whistleblowing.



FENGYAO DING

YEAR: Senior

HOMETOWN: Albany, Calif.

Growing up in a family that loves math and science, Fengyao took to science at a young age, joining in science conversation around the dinner table and visiting her father’s laboratory. The first time she visited her father’s laboratory he conducted a simple experiment on her mother’s vision.

Her science upbringing has inspired Fengyao to pursue a career with both STEM and humanity-based consequences. Her favorite subject in school is Physics and she is a tutor at the Math Student Center.

Fengyao speaks English, Chinese, and French. She enjoys ice skating as well as playing the flute, piano and harp. She also participates in her school’s math club. A huge fan of *Pride and Prejudice* if Fengyao could meet one person in history it would be Jane Austen.



CRISTIAN GUTU

YEAR: Senior

HOMETOWN: Easton, Conn.

Cristian found a passion for STEM at a young age, developing a program using a few lines of code with relative ease. His interest was sparked by his will to learn and create games he could not find.

Cristian hopes to major in Computer Science in college and has applied to a number of schools with strong computer science programs. Computer science reaches far beyond the gaming world and Cristian knows that it is imperative to future technology. If Cristian could speak to one person in history it would be Neil Armstrong, to ask him how computing assisted in providing safety and gaining/parsing of information.

Outside of computers and school, Cristian enjoys playing soccer, especially when he is on defense. He is also part of his school's FIRST Robotics Club, and speaks a wide variety of languages including English, Romanian, Spanish and Russian.

He still enjoys playing computer games and he was even able to meet the creator of Minecraft, Markus Persson. Cristian says by meeting Markus, creator of one of the most popular games, Cristian was able to learn that experimentation is the true driver of success.

TEAM COMPETITORS

JOHN HEATH, South Pasadena High School, South Pasadena, Calif.

JUNHYUK OH, South Pasadena High School, South Pasadena, Calif.

EMMA WINSON, The Hockaday School, Dallas, Texas

PROJECT: Utilizing an All Synthetic Epitope Targeting Strategy to Develop Potential Inhibitors against Allosteric Sites on the Oncoprotein KRas

FIELD: Biochemistry

MENTOR: James R. Heath, Elizabeth W. Gilloon Professor of Chemistry, California Institute of Technology; Ryan Henning, graduate student, California Institute of Technology

"The reason we struggled to get as much done as possible every day was the end goal - saving lives."

John Heath, JunHyuk Oh, and Emma Winson embarked on their research journey in the field of oncology with the hopes of gaining a better understanding of new, innovative ways to cure cancer. Together, at

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the California Institute of Technology, they created a ligand that can serve as the foundation for continued research for a drug to treat one of the most lethal and notoriously evasive proteins in cancer. Their research developed a capture agent that binds onto a protein called KRas, which in mutated form has the potential to create tumors by controlled growth of cancerous cells.



JOHN HEATH

YEAR: Junior

HOMETOWN: South Pasadena, Calif.

John Heath's middle school math teacher ignited his passion for STEM. Later, his first science project, also conducted with current team member Joseph Oh, was creating solar cells from donuts, specifically, solar cells from the Titanium Dioxide (a semiconductor) within the white powder coating certain donuts - although they found that anthocyanin, a purple dye from hibiscus flowers or berries bound best to TiO_2 and produced the most energy. For John, STEM allows him to systematically find and solve problems, improving our understanding of the world. He is especially interested in chemistry, because he enjoys the abstract reasoning involved and its ability to explain natural phenomena.

John hopes to major in chemical engineering and has applied to various schools with strong computer science programs, including MIT, Stanford, UC Berkeley, Rice, Johns Hopkins, and Georgia Tech. With his strong academic achievement, and extra-curricular activities including Boy Scouts, cross country and playing guitar in his school's jazz band.

If John could meet any person in history, he would love to meet John Lennon since he inspired the music he enjoys listening to today.



JUNHYUK OH

YEAR: Junior

HOMETOWN: Incheon, South Korea

JunHyuk had heard about the capture agent method used for treating malaria and its possible use-case for cancer, so when his aunt passed suddenly from kidney cancer right before the advent of this research, the event pushed and inspired him to do this project and persevere until the team found results.

JunHyuk plans on applying to University of California at Berkeley, University of California at Los Angeles, University of California at Davis, University of Southern California, Stanford and Georgia Tech. He would like to pursue a degree in immunology, biology, and virology and aspires to be an immunologist, field biologist or research scientist.

JunHyuk is a strong musician and plays the flute, piano, guitar and tuba. Outside of the classroom, he participates in the school marching band. He is also an active member of his school's Campus Christian Fellowship and volunteers as a praise leader at his father's church.



EMMA WINSON

YEAR: Senior

HOMETOWN: Dallas, Texas

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Emma Winson's first science projects started with plaster globes and fish tanks, the latter which sparked her interest in oceanography and STEM. Now in high school, she is excited to learn more about stem cell research and the possibilities of using stem cells in harvested cord blood.

Emma is applying to Bowdoin College, Bates College, Dartmouth College, Massachusetts Institute of Technology, University of Texas, Reed College, Rice University, Columbia University, and Middlebury College, hoping to pursue a degree in materials science, engineering, biomedical engineering, or biological chemistry. She aspires to become a medical or academic consultant.

Outside of the classroom, Emma is captain of the varsity rowing team at her school and one of her proudest moments was winning the Stotesbury Cup Regatta with her doubles partner during her junior year.

If Emma could meet a historic figure, she would like to speak with Margaret Sanger about how birth control revolutionized society and affected women in the workplace.

TEAM COMPETITORS

KWONIL KO, Cushing Academy, Ashburnham, Mass.

SEUNG HWAN AN, Taft School, Watertown, Conn.

PROJECT: Avoiding Monochromatic Configurations in the Multi-Colored Plane

FIELD: Mathematics

MENTOR: Dan Ismailescu, Professor of Mathematics, Hofstra University

"We believe that STEM is intended to understand the world in simple, logical fashion."

Kwonil and Seung Hwan's project is based on the Euclidean Ramsey Theorems, in particular the cases of 3, 4, 5 colorings. Results in Ramsey-type problems help explain natural phenomena that are constructed certain patterns and could aid in the creation of student class schedules or designing a subway blueprint more efficiently and quickly.



KWONIL KO

YEAR: Senior

HOMETOWN: Seoul, Korea

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Kwonil Ko, who also goes by Kobe, was inspired to pursue mathematics when he was introduced to the *4 Color Map Theorem* in the 6th grade. He was captivated by both the simplicity and complexity of the theorem and was motivated to develop his current project to be widely applied to the real world.

Combining his passion for mathematics with his current organic chemistry courses, Kwonil has become genuinely enthralled by the unlimited possibilities of choosing target molecules and creatively elucidating multiple chemical mechanisms in a logical order. Kwonil is fascinated with retrosynthetic analysis and wants to pursue a career in chemical engineering or as a high frequency trader on Wall Street.

Outside of school, Kwonil plays for the varsity soccer team at his school. While on a team trip to Boston College, he ran into pro soccer player, Jermain Jones, who scored a goal for the U.S. against Portugal at the World Cup. Kwonil also enjoys skiing and baseball, and plays the violin in his free time.

If he could talk with anyone from history, it would be Steve Jobs because he would like to learn how Jobs' charismatic and straightforward way of talking motivated his coworkers.



SEUNG HWAN AN
YEAR: Junior
HOMETOWN: Boston, Mass.

Seung Hwan An, or Sonny as his friends call him, stoked his interest in math and science after reading until the pages were ragged a book called "The Number Devil: A Mathematical Adventure" as a child. He was inspired to research topics concerning different arrangements of patterns on a single plane. With his project, Seung Hwan would like to better explain why we continue to see certain patterns in natural phenomena. The biggest challenge he found was coming up with the simplest proof as possible.

Enamored by physics in school, he loves the idea that scientists can attempt to discover the inner working of the universe with equations and numbers. To Seung Hwan it seems like a surreal beauty that we can describe the world around us with mathematical precision and accuracy.

Inspired by his grandfather's strong will and vision for his family, Seung Hwan aspires to be an entrepreneur who uses science to improve the world. Outside the classroom, Seung Hwan serves as the class chair for his school's student government. He enjoys taking on an active role on campus even as a traditionally introverted student. Seung Hwan loves physics and is a peer tutor at his school and volunteers at local middle schools teaching STEM education. Seung Hwan plays also plays the violin and tennis and speaks Korean and Spanish.