June 2016 Summer Institute Schedule

Time	Monday	Tuesday	Wednesday	Thursday	Friday
9:00	Greeting	Greeting	Greeting	Greeting	Greeting
9:30	Introduction to Encryption	Anatomy of Rockets	Rocket Aerodynamics	The Nose Cone Experts	Rocket Groups: Countdown to Launch!
10:30	Snack & Group Bonding Activity	Snack & Group Bonding Activity	Snack & Group Bonding Activity	Snack & Group Bonding Activity	Snack & Group Bonding Activity
11:00	Scavenger Hunt	Cryptology	Radar Mapping	Racing Against Friction	We Have Lift-Off: 3 Launches
12:00	Lunch	Lunch	Lunch	Lunch	Lunch
1:00	Pre-Surveys & Tour of Science Facilities at CSS	Rocket Propulsion	Balloon Staging	Rocket Construction	Post-Surveys & Prepare for Final Launches
2:00	Minute to Win It Activities	Minute to Win It Activities	Minute to Win It Activities	Minute to Win It Activities	Minute to Win It Activities
2:30	Introduction to Rockets: What Do We Expect? Basic Launch	Rocket Transportation	Parallax Distances	Rocket Construction	Final Launches: What Have We Learned? Closing
3:30	Wrap-up & Load Bus for Home	Wrap-up & Load Bus for Home	Wrap-up & Load Bus for Home	Wrap-up & Load Bus for Home	Wrap-up & Load Bus for Home

June 2016 Summer Institute Activities

Monday

9:30 AM - Introduction to Encryption

Objective: Students will be able to decrypt messages using a cryptography key.

Background Information: Decrypting messages that have been coded with a key can be as simplistic as puzzles found on cereal boxes to as complex as coding that requires a supercomputer to solve. Students will be provided coded messages and keys to decode these messages. Subsequently, students will create their own key and code a message that will be passed to another participant. Each participant will then attempt to decode the message given to them without the aid of the key. Strategies for decoding messages based on patterns in words and phrases will be shared and employed. For those messages that are not successfully decoded, the student created key will be shared and the message decoded.

11:00 AM - Scavenger Hunt

Objective: Students will engage in a scavenger hunt to assist with team building and to practice decryption skills.

Background Information: Students will embark in teams of two on a scavenger hunt around the CSS campus with coded messages and clues that utilize their grade appropriate math skills. The encryption key to the coded messages will be shared with the students. The scavenger hunt is designed to enhance team building skills and foster student cooperation.

1:00 PM - Pre-Surveys & Tour of Science Facilities at CSS

Objective: Students will be surveyed to measure awareness of STEM careers, as well as their awareness of the impact that science and math has on our everyday lives and the world around us.

Background Information: Students will individually complete two surveys, one focused on STEM careers and the other on how math and science are all around us and can be found in our everyday lives. The surveys at the start of the June 2016 Summer Institute will contain quantitative as well as qualitative questions to measure student's knowledge and awareness of the two focus objectives described in the previous sentence. Corresponding bookend surveys will be given at the beginning and at the end of the June 2016 Summer Institute in order to measure student's growth in their knowledge and awareness of the two focus objectives.

2:30 PM - Introduction to Rockets

Objective: Students will be introduced to the history of rockets, current developments, and the future of space exploration.

Background Information: The twentieth and twenty-first centuries brought forth the development of rockets that have enabled mankind to escape the bonds of planet Earth and go into the great "final frontier" that has mystified mankind since the first human looked up at the sky. Rockets have become commonplace in our everyday vernacular and modern culture to the extent that they are accepted technologies. What the general "nonscientist" or "non-engineer" tend to misunderstand is how complicated and technically involved rockets actually are. The basic principles of rocket science might be easily explained to primary school-aged students, but indeed, the devil is in the details. It is often stated as a major achievement of mankind that the Space Shuttle has something on the order of two million parts. To date, tremendous progress has been made in rocket design and we have been witness to significant improvements in fuel efficiency, safety, and speed.

Tuesday

9:30 AM - Anatomy of Rockets

Objective: Students will be able to describe and state the function of the general components of various rockets.

Background Information: Rockets typically consist of body tube, nose cone, rocket fins, launch lug, recovery system, and the propulsion system (engine). The body tube is the main body and holds the nose cone in place. The rocket fins at the bottom of the rocket provide stability during flight. The body is often a hollow cylinder because it reduces the amount of surface area that is in contact with the air which in turn reduces drag. The length of the rocket does affect how the rocket performs. As the rocket becomes longer, it creates more surface area and this increase in surface area causes the rocket to have a straighter path in flight. For this reason, fins are added to the rear of many rockets to add surface area, and stabilize the rear of the rocket. The nose cone is one of the most crucial parts of a rocket, as it acts as a way to punch a hole in the atmosphere. Over the course of time, there have been many designs for the nose cone of rockets. However, most of them have tried to imitate the aerodynamics of bullets. The velocity and purpose of the rocket plays a very important role in nose cone design. At supersonic speeds, a conical shaped cone is more preferable because it punches easily through the atmosphere. However, at subsonic speeds, a domed shape cone is preferred because it causes less drag due to less surface area.

11:00 AM – Cryptology

Objective: Students will be able to encrypt and decrypt messages using a Caesar cipher and a Vigenere cipher.

Background Information: The so-called Caesar cipher is a cryptosystem that assigns a letter of the alphabet to another letter of the alphabet by shifting each letter of the alphabet by a fixed algorithm. Since there is a limited number of letters of the alphabet, there is a limited number of possible shifts. The Vigenere cipher requires a key word that will first shift each letter of the word to be encoded. Each letter of the word to be encoded is identified by a position 0 - 25 (A is located in position 0, not 1). The code word then shifts each letter, and that result is evaluated modulo 26.

1:00 PM - Rocket Propulsion

Objective: Students will be able to compare and contrast the energy sources available for use in rocket propulsion systems.

Background Information: Rocket propulsion is achieved by the thrust produced via the directional ejection of matter. Three traditional energy sources for propulsion are Mechanical, Electrical, and Chemical. Two of the more modern energy sources for propulsion are Solar Radiation and Nuclear. Propulsion systems can alternatively be categorized into the following general types: Propeller and Jet. Jet propulsion can be sub-categorized into the following general types: Air-Breathing Propulsion (Turbomachinery Based and Pure-Duct Based) and Rocket Propulsion (Liquid Chemical Propellant Fuels and Solid Chemical Propellant Fuels). A majority of propulsion systems utilize the thermodynamic expansion of gas, where the internal energy of gas is converted into kinetic energy.

2:15 PM - Rocket Transportation

Objective: To construct a simulated rocket out of a balloon and use it to carry a payload vertically.

Background Information: The mass of a rocket can make the difference between a successful flight and a rocket that just sits on the launch pad. As a basic principle of rocket flight, a rocket will leave the ground when the propulsion system (engine) produces a thrust that is greater than the total mass of the vehicle (rocket). Large rockets, able to carry a spacecraft into space, have serious weight problems. To reach space and proper orbital velocities, a great deal of propellant is needed; therefore, the tanks, engines, and associated hardware become significantly larger. Up to a point, bigger rockets fly farther than smaller rockets; however, when they become too large, their structures weigh them down too much. A solution to the problem of giant rockets weighing too much can be credited to the 16th-century fireworks maker John Schmidlap. Schmidlap attached small rockets to the top of big ones. When the large rockets exhausted their fuel supply, the rocket casing dropped behind, and the remaining rocket fired. Much higher altitudes can be achieved this way. This technique of building a rocket is called staging. Thanks to staging, not only can we reach outer space in the Space Shuttle, but we can also reach the Moon and other planets using various spacecraft.

Wednesday

9:30 AM - Rocket Aerodynamics

Objective: Students will learn how air flows over a rocket and how this affects drag and stability.

Background Information: When a solid body is moved through a fluid (gas or liquid), the fluid resists the motion. The object is subjected to an aerodynamic force in a direction opposed to the motion of the object and we call this drag. There are many factors that affect aerodynamic forces. Aerodynamic forces are generated and act on a rocket as it flies through the air. The magnitude of the aerodynamic forces depends on the shape, size, and velocity of the rocket and some properties of the air through which it flies. By convention, the single aerodynamic force is broken into two components: the drag force, which is opposed to the direction of motion; and the lift force, which acts perpendicular to the direction of motion. The lift and drag act through the center of pressure which is the average location of the aerodynamic forces on an object. In this activity, students will learn how shape, size, mass, viscosity, compressibility, velocity, and inclination of flow affects a rocket's motion.

11:00 AM - Radar Mapping

Objective: Students will learn how distance is determined by there-and-back signal propagation time.

Background Information: Radar provides an accurate method of determining distances and can be used both on rockets and to track rockets. Radar can also be used to measure the distance to nearby solar system objects and to map their surface features, including from orbit. We will calculate the average distance of the moon from Earth using there-and-back light travel time and we will look at altitude maps of the inner rocky planets (Mercury, Venus, and Mars) and compare them to Earth, as well as to the outer gas giants and their icy moons. We will discuss the processes that shape surface features. Students will learn and use the following equation: $d = rt$ (distance = rate*time)

1:00 PM - Balloon Staging

Objective: To simulate a multistage rocket launch by using 2 inflated balloons that slide along a fishing line by the thrust produced from escaping air.

Background Information: Traveling into outer space takes enormous amounts of energy. This activity is a simple demonstration of rocket staging that Johann Schmidlap first proposed in the 16th century. When a lower stage has exhausted its load of propellants, the entire stage drops away, making the upper stages more efficient in reaching higher altitudes. In the typical rocket, the stages are mounted one on top of the other. The lowest stage is the largest and heaviest. In the Space Shuttle, the stages attach side by side. The Solid Rocket Booster's attach to the side of the external tank. Also attached to the external tank is the Shuttle orbiter. When exhausted, the SRBs jettison. Later, the orbiter discards the external tank as well. Thanks to staging, not only can we reach outer space in the Space Shuttle, but we can also reach the Moon and other planets using various spacecraft.

2:30 PM - Parallax Distances

Objective: Students will learn how to measure distance using parallax and then practice using parallax on the CSS campus.

Background Information: Parallax - the shift in position of a nearby object against a distant background when viewed from different perspectives - provides another method of measuring distances. Students will be given a simplified formula to estimate distance based on measuring two angles and the baseline and subsequently, we will practice outside on the CSS campus using binoculars. We will also explore how parallax can be used to determine distances to nearby stars and introduce a hierarchy of scales moving from Minnesota to the USA to the Earth to the solar system to nearby stars to our Milky Way galaxy, and even further.

Thursday

9:30 AM - The Nose Cone Experts

Objective: Students will experiment with different nose cone shapes to determine the advantages and disadvantages of each type.

Background Information: Aerodynamics is the branch of science that deals with the motion of air and the forces on bodies moving through the air. There are four forces that act on a rocket: lift, drag, weight, and thrust. Drag is a force that opposes the upward movement of a rocket and it is generated by every part of the rocket. Drag is a type of aerodynamic friction between the surface of the rocket and the air. Factors that affect drag include the size and shape of the rocket, the velocity and inclination of flow, and the mass, viscosity, and compressibility of the air.

11:00 AM - Racing Against Friction

Objective: To understand how friction affects the speed of a vehicle.

Background Information: Working in space can be tricky. With no gravity or friction to keep things in place, relatively simple tasks can become complicated ordeals. To prepare for the rigors of working in space, astronauts train in many different facilities on Earth. This activity will introduce students to the concept of friction being a slowing force.

1:00 PM - Rocket Construction

Objective: Students will construct a rocket with given supplies to be launched multiple times on Friday in order to examine variables and test concepts gained during the institute.

Background Information: Students will utilize the knowledge gained from the week's seminars to evaluate variables impacting rocket construction that impact optimal performance and use components supplied to create rockets. Working in teams, students will discuss and construct rockets evaluating options in preparation for launching their team's rockets on Friday.

2:30 PM - Rocket Construction

Objective: Students will construct a rocket with given supplies to be launched multiple times on Friday in order to examine variables and test concepts gained during the institute.

Background Information: Students will utilize the knowledge gained from the week's seminars to evaluate variables impacting rocket construction that impact optimal performance and use components supplied to create rockets. Working in teams, students will discuss and construct rockets evaluating options in preparation for launching their team's rockets on Friday.

Friday

9:30 AM – Countdown to Launch!

Objective: Students will work in small groups to prepare launch sites and discuss strategies for identifying correlation of cone shapes and rocket launch success.

Background Information: Launch conditions greatly impact rocket liftoff and successful flight. Some variables such as weather are beyond our ability to control and can result in launch delay. Other factors such as launch pad construction and angle of flight are within our control. Students will work in small teams to prepare launch sites for their rockets under the direction of a faculty member or trained college student.

11:00 AM - We Have Lift-Off!

Objective: Students will conduct 3 rockets launches with varying cone head shapes.

Background Information: Prior to launching team constructed rockets, students will be asked to evaluate five cone head shapes and predict the cone heads that will provide optimal flight. Teams will be asked to select 2 cone heads that they predict will provide the optimal performance to save them for the final launches later in the afternoon. The remaining 3 cone heads will be used for the 3 launches during this session. Guided discussion with each team will require teams to support their selection of optimal cone head shapes using terminology and concepts learned during the week's institute.

1:00 PM - Post-Surveys & Prepare for Final Launches

Objective: Students will be surveyed to once again measure awareness of STEM careers, as well as their awareness of the impact that science and math has on our everyday lives and the world around us. Students will also work in small groups to prepare launch sites and discuss strategies for identifying correlation of cone shapes and rocket launch success.

Background Information: Students will individually complete two surveys, one focused on STEM careers and the other on how math and science are all around us and can be found in our everyday lives. The surveys at the start of the June 2016 Summer Institute will contain quantitative as well as qualitative questions to measure student's knowledge and awareness of the two focus objectives described in the previous sentence. Corresponding bookend surveys will be given at the beginning and at the end of the June 2016 Summer Institute in order to measure student's growth in their knowledge and awareness of the two focus objectives.
Prior to final lift-off, student rocket teams will be asked to evaluate launch and flights of the 3 morning launch session flights. A focus on what went as expected as well as what results were not expected will be discussed within each rocket team. Subsequently, whole group time will be utilized to compare and contrast results to determine variables that may be related to materials such as nose cone shape verses technique or other team controlled variables. Teams will be asked to review their choice of the final 2 cone head shapes reserved for the final 2 launches and review variables within the team's control in order to produce optimal launch and flight performance.

2:30 PM - Final Launches!

Objective: Students will conduct 2 rockets launches with team-identified optimal cone head shapes.

Background Information: In this final session, students will analyze the components that resulted in success or failure, of the 3 morning flights prior to conducting their team's final 2 flights. A faculty member and/or a CSS Math or Science Club member will work closely with each team to stretch analysis and questioning of techniques and results. Whole group time will follow completion of the final 2 launches in order to provide time for groups to share and compare/contrast their results and findings.

3:00 PM - Closing

Objective: Students will demonstrate proficiency of the institute's goals through verbalizing their conclusions and what they learned during the week's activities.

Background Information: Students will compare and contrast launch results as a whole group to discern similarities between successful launches and formulate correlations found. Students will verbalize skills and concepts strengthened during the Institute. Students will obtain the 2016-2017 academic year Lincoln Park Middle School Math/Science STEM Club meeting and event schedule and indicate their interest levels for each of the planned club meeting topics and events.

2016 – 2017 Academic Year Lincoln Park Math/Science STEM Club Meeting Topics

The following provides an overview of the monthly club meetings which will be held on the Lincoln Park campus, unless otherwise noted.

September

Students who attended the June 2016 Summer Institute will receive encrypted invitations hand written by CSS Math and Science Club members via USPS mail inviting them to the first Lincoln Park Math/Science STEM Club meeting. These students will be encouraged to bring a friend with them to this first club meeting. Informational flyers will be posted around the Lincoln Park school inviting all Lincoln Park students to join the Math/Science STEM Club and to attend club meetings. The first meeting will primarily focus on reviewing and strengthening the encrypting and decrypting skills gained during the June 2016 Summer Institute. Students who attended the June 2016 Summer Institute will be encouraged to actively assist in the teaching of these skills to students that did not participate in the June 2016 Summer Institute.

October

Students who attended the June 2016 Summer Institute and/or the September Lincoln Park Math/Science STEM Club meeting will be invited to attend an outing to Engwall's corn maze. This bonding activity will include students from the CSS Math and Science Clubs, CSS Math and Science Faculty, and the Lincoln Park Math/Science STEM Club Faculty Leader.

November

Potential meeting topics are being discussed. Current session theme's being considered focus on the physics and math involved for flight as related to: Santa Clause's Sleigh, Rudolph and the Other 8 Reindeer, Superman/Supergirl, Batman, Iron Man, Rocket Man, and/or other superheroes.

January

Lincoln Park Math/Science STEM Club members will join CSS Math and Science Club members for an evening of interactive strategy game playing. This open and engaging time is designed to foster mentor-mentee relationships, along with providing the opportunity for Lincoln Park students to learn more about academic degrees and professional careers in STEM fields through conversation with CSS Math and Science Club members. This bonding activity will be held on the CSS campus and will include CSS Math and Science Faculty, as well as the Lincoln Park Math/Science STEM Club Faculty Leader.

February

Students will look at an incandescent lamp through diffraction gratings to establish that higher temperatures produce brighter emission and a bluer color. They will also compare the apparent brightness of the lamp at a near versus far distance to define luminosity versus flux. These concepts will then be used to sketch out and explore the HR diagram for main-sequence stars, and we will showcase some prominent red and blue stars that they can view at night. This topic will serve as part of the club members' preparation for the April trip to the UMD Planetarium and as an opportunity to build upon foundational concepts related to the 2017 Summer Institute theme of astronomy.

March

At this club meeting, we will use the Galaxy Zoo citizen science project and the Sloan Digital Sky Survey to look at different types of galaxies. Students will develop their own classification scheme initially, and compare color and morphology properties, then we will discuss spiral versus elliptical galaxies and how spirals, with more gas and dust, also contain more ongoing star formation and hence more young luminous blue stars. This topic will serve as part of the club members' preparation for the April trip to the UMD Planetarium and as an opportunity to build upon foundational concepts related to the 2017 Summer Institute theme of astronomy.

April

Lincoln Park Math/Science STEM Club members that have attended a minimum of 3 club meetings prior to the April club meeting (not including the outing to Engwall's corn maze) will be invited to attend an outing to the UMD Planetarium. This bonding activity will include students from the CSS Math and Science Clubs, CSS Math and Science Faculty, and the Lincoln Park Math/Science STEM Club Faculty Leader. The overriding theme of the 2017 Summer Institute will be astronomy and this final club meeting of the 2016-2017 academic year will be utilized to foster interest in the 2017 Summer Institute.

Note

It is our intention to seek input from Lincoln Park Math and Science Faculty in regards to possible ways to further enhance the Lincoln Park Math/Science STEM Club meetings and events.