Project ID: 731

Junior Division

Physics and Astronomy

Athaniel Almera
De Portola Middle School
Gr. 8

The Effects of Different Masses of Roller Coaster Trains on Velocity

AWARDS:

US Metric Association Award Winner

This project investigated how the change of mass affects the roller coaster's speed using an increase of quarters. Each quarter weighs 7 grams each and I measured the speed of the different masses. These 4 different masses, which includes 6 quarters (71 grams), 4 quarters (59 grams), 2 quarters (48 grams), and finally 0 quarters (36 grams because of the original weight of the train) were trialed 5 times and recorded though stopwatch (human tracked). After the results of the data were written, I found the average to find the speed. The track I created was 200 centimeters, or 2 meters and the downhill was a roller coaster element of a double helix. The stopwatch starts when the hand lets go of the train and stops when it hits the braking system (a plastic piece at the end of the track).
The results I found show that my original hypothesis was supported. The train with the most mass produced a higher speed then decreased as the masses decreased. The heaviest train, (71 grams) finished with a constant speed of 2.2 meters per second (m/s), with the 59 gram train following at 2.08 m/s, 2 m/s at 40 grams, and lastly 36 grams with an average speed of 1.89 m/s. The train with 6 quarters had the highest average speed because of potential energy (PE) and kinetic energy (KE). An increase in PE and KE raises the energy put into speed and would lead to a higher mass and speed output.

Project ID: 732

Junior Division

Physics and Astronomy

David Arshakian

Mt. Helix Academy

Gr. 7

How Does the Spin Affect the Trajectory of a Kicked Soccer Ball

Does the spin trajectory of a kicked soccer ball? I hypothesized that if I kicked the ball at the center point this would create the least number of spins. For my procedure I placed the ball on each side of he field and I hit the ball with the outside part of my foot, on the center, left and right points of the soccer ball. The results were that the right side spun an average of 9.7 times, the left side spun an average of 4.3 times and the center spun an average of 8.3 times. My hypothesis was proven to be incorrect because when I kicked the soccer ball on the right side, this created the most spins. The center point was then next with an average of 8.3 spins and then lastly, the right point produced an average of 9.7 spins. Next time if i did this again i would try hitting the ball differently and seeing if weight affects the speed.

Project ID: 733

Junior Division

Physics and Astronomy

Cole Ceresia

St. Gregory the Great Catholic School

Gr. 7

Effects of Air Pressures in a Soccer Ball

This experiment, "Effects of Air Pressures in a Soccer Ball" was tested to see what PSI would travel the farthest on average using a kicking machine to apply a constant force to a size 5 Nike soccer ball model FB2985-100. Observations of kicking a flat ball versus a properly inflated ball have demonstrated marked differences in distance traveled. Therefore, my hypothesis is if the distance a soccer ball travels is related to its internal air pressure, then a soccer ball that is inflated the most will travel the furthest. This project's materials will consist of an electric ball inflator, kicking machine, level grass or turf, 1 Nike soccer ball model FB2985-100, a pencil, paper, measuring stick, and an anemometer and thermometer.

I built a kicking device with wood and a spring. The device had a string Stopper that acted as a guide for how far to retract the handle. I used a size 5 Nike ball inflated with an inflator with a gauge to measure pressure. I tested various psi levels from low to high. I tested each psi level five times each and measured the distance the ball traveled. I tested windspeed to make sure it did not affect the results. I confirmed that the ground was flat.

In the end, the hypothesis was correct up until psi of 12 when 12 did not go the farthest as predicted. The ball inflated to psi 10 went the farthest on average beating 12 by 0.4 feet.

Project ID: 734

Junior Division

Physics and Astronomy

Zoey Chen

Carmel Valley Middle School

Gr. 8

Estimating the Distance Between the Moon and Earth from the 2023 Solar Eclipse

AWARDS:

San Diego Astronomy Association - Junior Division 1st Place

Learning ideas from ancient Greek astronomer Hipparchus, we estimated the distance from the Moon to the Earth using the partial solar eclipse in San Diego on Oct. 14, 2023. Using solar eclipse pictures taken from shadows on that day, we measured the distance from San Diego to the nearest location where a full annular solar eclipse can be observed at the same time (for example, Lake View in Oregon). Assume if we know the diameters of the Sun and Moon, then we can estimate the distance of the moon to earth in relation to the distance from the Sun to Earth using the calculated percentage of partial solar eclipse in San Diego. As well as the distance from San Diego to Lake View where the full annular solar eclipse can be seen at that time using geometry of the similar triangles. Using the ratio of the overlap during the solar eclipse, we estimated how much of the sun's radius isn't covered by the moon, which is 0.531R, where R is the radius of the sun. We used this number and the distance from San Diego to Lake View as a ratio which is related to the ratio of the Sun to Earth to the Moon to Earth distance. The results that we got was 398,993 km which is close to the actual distance from the moon to Earth, 384,400 km. Using geometry and solar eclipses we can estimate distances in space.

Project ID: 735

Junior Division

Physics and Astronomy

Blake Huppert

Nazareth School

Gr. 7

Does Tennis Racquet Construction Affect Different Performance Results?

My project's title is "Does tennis racquet construction affect performance results?" Through the years tennis racquets have continually evolved in their material, shape, and overall construction. Today's racquets consist of one of three types: graphite, metal composite, and aluminum racquets. All three differ in their construction of materials and properties (Miller). The design of the racquet's throat is the primary contributor to the racquet's flex and stiffness. Higher end racquets have their throats made from the same piece of metal as the head and shaft. Beginner and lower priced racquets have their throats made from a separate piece of metal attaching on either side of the shaft at the bottom of the head. (Crim)

My hypothesis is that the single frame rackets will perform better than the double frame racquets. I set out to test these two types of racquets to measure their ball hit distance. I conducted my experiment by firing tennis balls at a control speed of 13.4112 meters per second at each racquet held steady in place by a workbench contraption I designed. Each test fired three new cans of Penn championship tennis balls. The variables used included: different tennis racquet brands and models. The dependent variable is the length/distance of the ball hit. My hypothesis was supported in the overall means that the single framed tennis rackets performed better than the double framed racquets. The overall mean for the double framed racquets is 118.19 cm. The overall mean for the single framed racquets is 151.722666667 cm.

Project ID: 736

Junior Division

Physics and Astronomy

Asher Kaplan
San Diego Hebrew Day School
Gr. 8

Baseball Spin Rate Testing

AWARDS:

CSEF Qualified

The purpose of this project was to see which rosin and sweat combination gave the baseball more revolution. The hypothesis stated that 3 taps of rosin and 3 sprays of sweat would give the baseball the most spin, however, this was not found true. The hypothesis was tested by a slow-motion camera filming a baseball rolling down a ramp and hitting a block that had different variations of rosin and sweat combinations and then watching the film and counting the full revolutions the baseball had spun. The results showed that the combination that had 6 taps of rosin and 6 sprays of sweat gave the baseball the most revolutions with an average of 6.56 revolutions.

Project ID: 737

Junior Division

Physics and Astronomy

Aaron Motola

San Diego Hebrew Day School

Gr. 8

Soccer Pendulum

What is the effect of the shoe position on the distance and accuracy of a soccer ball? Straight foot position, 90 degree angle foot position, and straight foot tilted position (foot tilted downward 45 degrees) were positions for the test. This test conducted 40 tests for each foot position, 20 of those were to test distance and the other 20 were to test accuracy. Accuracy was tested by putting a goal 50 yards away and distance was tested by using a measuring tape to see how far the ball went.

The 90º foot position resulted in the most effective position in distance and accuracy. The average distance for 90 degrees was 24.32 meters, tilted was 12.94 meters, and straight was 12.17 meters. The 90 degree position went almost double the distance of the other two positions. The 90 degree had 55% of goals successful, tilted was 50%, and straight was 45%. The 90º foot position had a 5% higher average number of goals scored than the other two foot positions. These results may have happened because the 90º position had the foot straight and the inside of the foot helps the ball go straighter. The hypothesis was supported because it predicted that the 90º foot position would get the better results because it is the strongest part of the foot. In conclusion the 90º foot position is the most effective foot position out of the positions tested.

Project ID: 738

Junior Division

Physics and Astronomy

Helene Nguyen
Nazareth School
Gr. 7

What Sunglass Material is Best at Preventing UV Radiation?

AWARDS:

DRS Daylight Solutions Award for Optical Physics and Engineering Junior Division
Armed Forces Communications Electronics Association (AFCEA) Junior Division Winner
CSEF Qualified

This project observed the penetration of UV light through different sunglass materials to determine which is most UV reflective. It was hypothesized that polycarbonate lenses would be the most UV reflective compared to the controls, regular glass and full penetration (no lenses in between UV lamp and meter). Results showed that the original hypothesis was not supported. Sunglass lenses made out of CR-39 were the most UV protective, and clear lenses made out of glass were the most UV reflective. Secure both the UV lamp (5cm on top of the radiometer) and the radiometer onto a ring stand using the clamps. Next, turn on the UV lamp and set the timer for 5 mins. After each minute, record intensity of the UV radiation without lenses for the control trial. Wait 5 mins after each trial to allow radiometer to cool down. Repeat steps for 4 trials. For the second control trial, place a piece of glass 2.5cm on top of radiometer and set 5 minutes. Similarly, record the intensity of the radiation after each minute, wait 5 mins after each trial to allow radiometer to cool down, and repeat steps for 4 trials. With the same procedure, place 1 of the 6 lenses (clear/sunglass) 2.5cm directly on top of the radiometer for 5 min. Record the intensity of the radiation after each minute, wait 5 mins after each trial to allow radiometer to cool down, and repeat steps for 4 trials for each type of lens.

Project ID: 739

Junior Division

Physics and Astronomy

Evan Nordstrom
St. Gregory the Great Catholic School
Gr. 7

Destruction of Metals

AWARDS:

American Society of Civil Engineers - Junior Division 2nd Place

The purpose of this investigation is to investigate various metals to determine which metals are resistant to corrosion near samples of water. The problem is that metals corrode when mixed with water. My hypothesis is if a metal is left in salt water for a long period of time, the metal will corrode, rot away and change different colors.

The procedure that I used to set up the experiment was the following. I acquired saltwater from a local ocean. Then, the next steps were performed. First, obtain the following: 1,000 ml of saltwater and of freshwater, 8 small white cups, 5 in pieces of copper, aluminum, tin, iron, metal plier, and a measuring cup. Pour 250 ml of saltwater into four cups, and freshwater into four cups. Cut the 5 inches metal pieces in half with pliers, place the metals in the corresponding cups.

The results were that both of the iron pieces rusted, the copper in saltwater turned the water blue, aluminum in saltwater had black lines all over and tin in saltwater had white dots on the surface. These metals changed because of chemical reactions with metal, water, and oxygen. After the metals were taken out the water, weight was placed on to it to test the strength. All the metals bent at 4 kg except tin which bent at 1 kg. In the end, the hypothesis was supported because most of the metals rotted, corroded, and changed a different color.

The conclusion of this experiment was the overall best metal was copper, it is good for strength and appearance. I observed that the copper metal had less corrosion than the other metals. The copper metal is something to consider in the construction of building over water.

Project ID: 740

Junior Division

Physics and Astronomy

Quinn Penstone-Smith

De Portola Middle School

Gr. 8

Color vs. Heat

This experiment was performed to see whether there is a difference in heat absorption between different color shirts of the same material, and to measure if the differences in absorption is significant. I found this out by laying four different color shirts, black, dark blue, light blue, and white, all of the shirts being the same material (100 % Polyester) style and brand, out in the sun over a seven hour time period. There were 21 trials on both days that I tested, and for each trial I would record the time, outdoor temperature, and heat of each of the color shirts. I measured the heat by using a UV heat gun that measures the surface temperature of the shirts. The black shirt absorbed an average of 118 degrees F, the dark blue shirt absorbed 112.8 degrees F, the light blue shirt absorbed 80.8 degrees F, and the white shirts absorbed 74.2 degrees F on average. The average difference of heat absorption between the black and dark blue shirt was 5.2 degrees F. The average difference between light blue and black was 37.2 degrees F. And finally, the average difference between black and white was 43.2 degrees. In conclusion, the black shirt absorbed the most heat and white absorbed the least. The heat absorption of different colors is significant because it proves that the color of shirts impacts the rate of absorption significantly.

Project ID: 741

Junior Division

Physics and Astronomy

Alfonso Sanchez
Extraordinary Private Home School
Gr. 8

Gathering Static Electricity

AWARDS:

CSEF Qualified
Thermo Fisher Scientific Junior Innovators Challenge Nominee

This project is a result of friction between materials creating static electricity to gather polystyrene balls into an opaque, modular shape with a desired goal of 100% opacity. Selecting a highly chargeable, light weight material such as polystyrene balls provided the experiment optimal results for producing a modular shape that would hold for a 5-minute minimum.

A translucent polycarbonate sheet held the greatest charge with the electroscope's foil leaves separating at a maximum of 5.5cm. Percentage of opaqueness was measured with a control area of 100 sq. cm. alongside a control quantity of polystyrene balls. By applying friction and comparing the surface area data acquired, the friction produced created a 35%,13%, 7.5%, and 34.25% coverage difference (hair, rabbit fur, wool, and skin respectively).

The percentage of opacity was greatly affected by the material used to apply friction and minimally affected by the amount of time friction was applied. Example, 35 seconds of friction yielded 50% opacity using "skin" while only yielding 9.5% opacity with "wool" for the same amount of time friction was applied. Opacity increased by 25% when friction was applied for 35 seconds to both "hair" and "rabbit fur".

Surface area coverage was found to be less than originally expected with opacity

Project ID: 742

Junior Division

Physics and Astronomy

Esther Sanchez

Extraordinary Private Home School

Gr. 7

Moving Light

At present form, this project is the result of mirrors reflecting a laser light source from one room into another room. The initial idea was to use as many mirrors necessary, but some success was achieved with the angle changing from as little as .017453rad to as much as 1.5184rad. This proved a 3-mirror difference.

A partial architectural floor plan of my house (1:50 scale) was used with mirrors placed parallel to the wall as a starting point. Essentially adjusting the angle of the mirrors to create a straight line onto the next mirror until the laser reached its destination. After the optimal angles were achieved on the floor plan, they were tested in a 1:50 scale architectural model with the actual laser light source in place.

The data shows that the slightest difference of .017453rad change on Mirror "D" directed the laser light source correctly. Moreover, not all mirrors had to be adjusted every time to show improvement as seen with Set "A": Mirror "D" & "F" consistently remaining at .64577rad & .24435rad after the 4th test. Unexpectedly, the measured distance of the laser light source was shortened from Set "A" to Set "B" at a considerable difference of 17.734m.

In conclusion, this experiment demonstrates that it is possible to reflect light from one room to another using 4 mirrors positioned at .34907,1.6057,.17453,.29671 radians. This research assists current literature on the topic of light being manipulated and adds to discoveries on moving, reflecting, and bending other forms of light.

Project ID: 743

Junior Division

Physics and Astronomy

Samuel Sternson
The Rhoades School
Gr. 8

Passive Cooling with Infrared Reflective Crystals

AWARDS:

Grand Award Runner Up – Junior Division Physical Sciences
Thermo Fisher Scientific "Advancing Equity Through Innovation" Award
Student Leadership Board Award - Junior Division
Armed Forces Communications Electronics Association (AFCEA) Junior Division Winner
DoD STEM Leadership Prize - Winner
CSEF Qualified
Thermo Fisher Scientific Junior Innovators Challenge Nominee

Millions of watts of electricity, often from burning fossil fuels, are used to actively cool structures. Passive cooling is a more environmentally friendly approach. One way to accomplish this is to coat structures with infrared (IR) non-absorbing, reflective materials. Crystalline sodium chloride (NaCl) does not absorb IR. I hypothesized that increasing the surface area of NaCl crystals would increase IR reflectance by providing more Air-NaCl transitions (Fresnel's Equations).

I grew clear NaCl crystals and scratched them with 320, 120, and 60 grit sandpaper to increase surface area. IR reflectance was measured before and after every scratch. Reducing the size of crystals increases surface area. I measured the IR reflectance of coarse sea salt (~2mm), table salt (0.25-0.5mm), and table salt ground with a mortar and pestle in multiple trials. I measured the passive cooling effects of the NaCl crystals by taking the temperature of copper plates heated by an IR lamp alone (control) or covered with test crystals. I also encased crystals in IR transparent plastic, to model an application requiring protection from water. I automated data collection with an Arduino. I collected 640 data points.

Scratched crystals showed more IR reflectance than smooth crystals. Coarse sea salt had the lowest IR reflectance, and the finest crystals had the highest IR reflectance. Copper plates protected by finley ground crystals were on average 14 C cooler or 26% cooler than the controls. These results were statistically significant.

These experiments demonstrate that NaCl crystals can be utilized for passive cooling.

Project ID: 744

Junior Division

Physics and Astronomy

Leah Vinck
Nazareth School
Gr. 7

What Fabric Blocks the Most UV Rays (Cotton, Linen, Polyester)?

AWARDS:

Armed Forces Communications Electronics Association (AFCEA) Junior Division Winner

The hypothesis for this experiment is that polyester will block the most UV rays between linen, and cotton. The procedure for this experiment is placing the UV meter against the wall and placing the flashlight 11.5 centimeters away from the UV meter. The first fabric tested is cotton, which I placed between the UV flashlight and the UV meter. I repeated this test four times. Next was linen, which I placed between the UV flashlight and the UV meter. I repeated this four times. Lastly, I placed polyester in between the UV meter and the UV flashlight and repeated this test four times. Polyester blocked the most UV rays; linen came in second and cotton last. Lastly, my hypothesis was supported, polyester is the most protective fabric to block out dangerous UV rays while in the sun.