Physics Fun With Cars

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Introduction

Physics is all around us. I realized this for the first time at some point in high school. I was trying to do a skateboard trick when a friend started telling me how each trick worked. He was able to explain how a certain force on the skateboard made the skateboard flip in a different manner. I had been watching skateboard videos for a long time and never understood how the skateboarders got the skateboard to do certain maneuvers. My friend then explained that physics explains the way everything moves. After my friend introduced me to physics, I understood better how to apply it to my own skateboarding.

It is these types of life experiences that I would like to provide to my students. I want them to understand the reasons why we learn the things we do in school.
In this unit, students will explore and learn about Newton's Three Laws of Motion and his Universal Law of Gravitation. The students will learn about these concepts through activities that revolve around NASCAR (National Association of Stock Car Auto Racing) racing and cars. Students will participate in activities using strategies that encourage experimentation, engagement, inquiry, and discussion. By the end of the unit, students will have developed a full understanding of tough concepts involving Newton's Laws. This unit will also offer background information to ensure teachers obtain fundamental information regarding the vocabulary and mathematical formulas related to Newton's Laws. The unit will include resources and activities that will ensure students have a great interest and understanding of Newton's Laws. This unit was written for a fifth grade class and is aligned with the Common Core State Standards.

Rationale

In education, we are currently working in a high stakes testing environment. North Carolina has an end of fifth grade Science test that has over eighty questions where students are required to know key vocabulary related to Newton's Laws. They are also required to be able to recognize the various concepts within pictures that portray the laws. In order for students to do well at analyzing a picture of an experiment on a test, I want to provide them with experiences that will help them make connections between real life and images on a test. The more real life experiences I can provide them, the better they can perform on the end of grade Science tests.

North Carolina recently transitioned to following the Common Core State Standards along with forty-four other states. This is great news because it means that students all over the country will be receiving instruction that is consistent and includes rigorous content and requires high-order thinking skills. The Essential Standard and Clarifying Objective from Common Core regarding Newton's Laws states the following: Understand force, motion and the relationship between them. It sounds easy enough, but in the past I have found it difficult to get my students to retain all of the intense vocabulary. I have noticed that the concepts are relatable to students, but they have difficulty understanding the true meaning of all the vocabulary that comes with Newton's Laws. I try to relay to them that Newton's Laws are common sense, and that Isaac Newton just gave the ideas their names such as: friction, mass, inertia, etc.

In the past I have taught Newton's Laws through a variety of experiments. The experiments did a great job demonstrating Newton's Laws, but I felt that they seemed random to the students, and that they were somehow separate. Students were not seeing the connections between the laws and how the vocabulary is necessary to understand each law. These experiments were all fun, and the students learned a lot from it, but I wanted to make my lessons better. I believe this unit will do exactly that! I want to teach Newton's Laws centered around one theme: Cars. I believe that by teaching all of Newton's Laws with the same theme, students will see the connections between each law and vocabulary words, and how they are related to each other. After the students gain an understanding of Newton's Laws and all related vocabulary, it is my hope that the students will be able to transfer and apply that information to new ideas and experiments.

In my school, it is sometimes hard to get boys to pay attention in class and to care about their own learning. I teach in an urban school where about 80% of the students are African American and 80% of the students are eligible for free or reduced lunch programs. Statistically speaking, economically disadvantaged African Americans "have little more than a fifty-fifty percent chance of finishing high school with a diploma. By comparison, graduation rates for Whites and Asians are 75 and 77 percent nationally. Males graduate from high school at a rate 8 percent lower than female students." (1) It is because of these graduation facts that I feel the need to truly inspire my students, especially the boys.

I believe that most boys in fifth grade, regardless of race are very interested in cars. They may not be interested in racing, but they definitely love cars, whether they are real or toys. By using cars as a central theme, my students will develop a deep understanding of Newton's Laws. Another reason I think cars will be a good theme for this unit is because I teach in Charlotte, North Carolina, which is the official headquarters of NASCAR (National Association for Stock Car Auto Racing). Charlotte has two major races a year that draw thousands of fans to the area to enjoy the excitement of racing. Charlotte is also the home of the NASCAR Hall of Fame. All but a few of the NASCAR teams are based in or around Charlotte, NC. With all of NASCAR surrounding the area, I know that most of my students have at least some background knowledge regarding

NASCAR. This unit will tap into that background knowledge and build on it to help students understand Newton's Laws.

Background

There are many difficult vocabulary words in each of Newton's Laws of motion and the Law of Gravitation. In this section, I will give a brief overview of each law, and include definitions for key vocabulary that are necessary for understanding the laws of motion.

Newton's First Law of Motion

Newton's First Law is also called Newton's Law of Inertia. Newton's first law of motion is often stated as: An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted on by an unbalanced force. This is a simple concept for adults, but can be confusing for students. It is best to break up the law into two parts. First of all, the concept of, an object at rest stays at rest, is simple enough for students. If no force is applied to an object, the object will never move. However, the more complicated part of the law is the explanation that a moving object will continue to move at the same speed and in the same direction forever unless a force is acted upon it (unbalanced force).

Students usually see this as untrue because they know that a rolling ball will eventually come to a stop. What they fail to understand is that the ball comes to a stop because there are forces acting on it. They cannot usually describe why the ball actually comes to a stop. The ball comes to a stop because of friction. On earth, gravity and friction will always be applicable to any object. To truly test Newton's first law, we would need to go to outer space where gravity and friction do not apply. An application of Newton's law that deals with cars: We have all felt Newton's law at work while riding in a car. If a person is traveling in a car, and the driver applies the brakes, the person will naturally lean forward into the seat belt. This is because even though the car is stopping, the person is not part of the car, so it tends to want to stay in motion. If not for the seatbelt, the person would not stop with the car. This also helps explain to kids the importance of seat belts.

Newton's Second Law

Newton's second law of motion can be formally stated as follows:
The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object. More simply stated, Newton is saying that the more force applied to an object, the more acceleration the object has. This relationship between acceleration and force is direct, meaning that as one increases, so does the other. The relationship between mass and acceleration however is inverse. That is, if mass

increases, then acceleration must decrease. This is putting common sense into new vocabulary for kids. Most of them understand that something that is heavier, it will take more work to move the object. This law can be stated as the following equations:

force = mass × acceleration ($F = ma$) and acceleration = force/mass ($a = F/m$).

Since acceleration is found by dividing force by mass, if the mass increases, then the acceleration obviously decreases for the same applied force. To demonstrate this law, and apply it to cars, think of two identical small cars, one with a small engine and one with a powerful engine. Because the tractive force at the tires is related to the engine power, the powerful car will out accelerate the weaker car. Now compare the powerful car to a similarly powerful tractor trailer. Because the tractor trailer has so much more mass, again the powerful car will out accelerate it. Lastly, let's consider the weaker car versus the powerful truck. Now who wins that little drag race depends on a lot of things and can't be answered here.

Newton's Third Law

In Newton's third law he states: for every action there is an equal and opposite reaction. At first, most students do not understand this law. One way to help get the point across is to think of a car crashing into a guardrail. When the car hits the guard rail, it smacks it so hard it knocks the pilings on their foundations and bends the railing all up. But the railing also smacks the car and the reaction force caves in the front of the car folding up the body work and bending the frame.

Newton's Law of Universal Gravitation

Newton defined the force of gravity in this way: Every particle of matter in the universe attracts every other particle with a force that is directly proportional to the product of the masses of the particles and inversely proportional to the square of the distance between them. This means that any object exerts a gravitational pull on any other object. So any two objects are pulling toward each other with the force of gravity. The more mass objects have, the more gravitational force acting between them. Newton found that this law is true for everything, including space and objects on earth. The same force that holds us to the earth is also guiding the moon and the sun. Gravitational force exists between any two objects, which is also known as the "Law of Universal Gravitation". Even though any two objects have gravitational forces acting between them, distance plays an inverse role in the relationship. The farther away an object is from another object, the less gravitational force acting on them.

One way to think of gravity and the distance relationship is that to orbit, an object must be traveling around another object. Because the gravity varies with the distance, for a stable orbit, the orbit velocity slows down the farther out the object is. The orbit of

Pluto is 246 years while the orbit of Mercury (the innermost planet) is just 89 days. Although a different effect, this is similar to why an ice skater spins slowly with her arms out but then speeds up when she pulls her arms in.

Another side is to consider what we weigh. Our weight is dependent on our mass and the mass of the earth on which we stand. If we stood on the little dwarf planet Pluto, we would only weigh a quarter of what we weigh on Earth.

Force

A force is commonly defined as a push or pull. When forces are balanced they are canceling each other out, and the object receiving the force does not move. When forces are unbalanced one force is said to be stronger than the other and the object will move. On Earth the force of gravity is always being applied to all objects. When we stand still on Earth, the reaction force of gravity is pushing back up through our shoes.

Friction

Friction is a drag force that holds back the movement of a sliding object. The force acts in the opposite direction of the way the object wants to slide. Friction not only happens between solid objects, but you can experience resistance to motion in liquids and gases. If the gas is air, this is known as air resistance or "drag". Friction is what allows the brakes on a car to work. Friction allows cars to "peel out" when accelerating hard. If there were no friction, a car's tires would just spin forever on the pavement and not propel the vehicle forward. A similar example to this would be to think about a car on ice. While friction is not absent, there is very little, which allows for the tires of a car to spin when in drive.

Speed

The speed of an object is measured by the distance an object travels in a specific amount of time. Speed is measured by the following: Speed = distance/time. Speed is very familiar to most students as they relate it to cars. Most students have an idea of what it feels like to go fast down the highway in a car. In a car in the United States, we measure speed as the distance we can drive in a specific amount of time. This is measured in miles per hour (mi/hr) but can be measured in a vast variety of units.

Motion

If an object is set into motion, then the position of the object is changed. It has motion, and the magnitude of the motion is the speed. Velocity is the vector of speed and a direction.

Velocity

Velocity is the speed and direction an object is traveling. If the position is ‘x’, then the velocity ‘v’ is $v = \Delta x/\Delta t$. A force is needed to change the velocity of an object. If the speed and/or direction of an object changes it is said that the velocity has changed.

Acceleration

When an objects’ velocity has changed it is said that it has accelerated. Acceleration is calculated by using the following equation:
Acceleration (a) is the change in velocity, (Delta-V or Δv), divided by the change in time, (Delta-t or Δt). So:

$a = \Delta v/\Delta t$.

The force relation is $a = F/m$, where F is the net force applied to a mass, m.

Mass

Mass is defined as the amount of matter in an object. It is important to point out the difference between mass and weight. Weight is the force measured by the gravitational forces acting on an object. This is why we technically weigh different amounts depending on whether we are on earth or if we are standing on the moon. Since mass is the amount of matter an object has, then mass would not change if you take the object to the moon. In other words, it is still made of the same amount of stuff.

Momentum

As an equation, the momentum of an object is equal to the mass of the object times the velocity of the object. Basically, mass that is in motion has momentum. Since momentum is dependent on two variables, think of momentum as how much an object's momentum would hurt me if it hit me. If a small object hits you at a quick speed/velocity, it might hurt. However, if a large object hits you at a small speed/velocity, it is possible it might not hurt, although it still could. However, if the mass of an object is large and its velocity is great, then you are in trouble! The object's momentum is its velocity times its mass.

Inertia

Inertia is known as the resistance an object has to a change in its state of motion. Objects at rest want to stay at rest. Objects in motion want to stay in motion. Basically, objects will keep on doing what they are doing unless a force is exerted on it. In linear motion, inertia is related to mass; however, if it is rotating, the inertia is also dependant on the shape. A steel pipe rotating about its axis has low inertia but if it is rotating like a propeller, then its inertia is greater and it becomes harder to stop.

Gravity

Gravity is a force which tries to pull two objects toward each other. Anything which has mass also has a gravitational pull. The more massive an object is, the stronger its gravitational pull is. The closer you are to an object, the stronger its gravitational pull is.

NASCAR

While its history stems from people who were delivering moonshine (illegal alcohol during prohibition), and trying to out-run police cars, NASCAR actually came into existence in 1949. Before then, moon-shiners and stock-car racers ran informal races for bragging rights regarding who had the fastest cars.(2) Later, stock-car racers began competing in races all over, but the downsides were considerable. The rules at each track were different. Some tracks were better than others for spectators. Stock-car racing was very un-organized. In 1947, Bill France Sr. held a meeting in Daytona, FL to give birth to the National Association for Stock Car Auto Racing (NASCAR). Two months later, the first NASCAR sanctioned race was held in Daytona. NASCAR was later incorporated, and in 1949 held its first event in Charlotte, NC in 1949. NASCAR was spreading and in 1950, the first asphalt super-speedway was created in Darlington, SC. Since then, racing has gone through major changes in technology, and marketing. (3)

NASCAR, and auto racing in general, have a huge advertising/marketing component. Racing teams are very expensive, “with costs spiraling upward -- estimates range from $5.5-6.5 million to run a competitive, top-20 team,” in the Nationwide Series. (4) Because of this, NASCAR teams have to line up many sponsors to help pay for the expenses of racing. “Being a primary sponsor of a team costs $350,000 to $500,000 per race, although corporations can usually cut a deal to sponsor a team for a full season.” (5) The driver of the car becomes a spokesman for many of the sponsors, and sometimes is the face of the company. After a race, it is not uncommon to see the winning driver get out of the race car and mention many of the team’s sponsors. This is part of many company’s advertising schemes. The company benefits from the time its logo is on the screen on television. Companies also pay for team members to mention their products during TV interviews.

Strategies

Inquiry

Science obviously lends itself to inquiry based learning. For each of Newton's laws, students will conduct several experiments to investigate the concepts. They will complete each experiment in a cooperative learning group. In group work, I find that students really learn from each other. As they experiment, the students will naturally have questions. I will encourage them to try to investigate further to encourage high order thinking. This might offer me a chance to learn as well as students often ask un-answerable questions. The students will work cooperatively to discuss ideas and answers to their own questions.

Note-taking

Students will be encouraged to take notes that help them analyze their own thoughts about physics. Students will write down their thoughts after watching a video to express their observations, predictions and ideas. Students will summarize readings to help them synthesize the information they learn. The goal is for the students to come up with an organization system that benefits them by expressing their ideas on paper.

Vocabulary

The vocabulary required for understanding Newton's laws is very intense for a fifth grader to understand. Students will create a vocabulary book to keep track of all of Newton's laws and the related vocabulary. By the end of the unit, the students will have done all of the following in their vocabulary book: 1) defined each vocabulary word, 2) draw a picture for each word that directly relates or expresses the word, 3) use the word in a sentence that provides context for what the word means, and 4) re-define the word using their own words. The students will also repeat the process for each of Newton’s laws.

Use of Technology

Videos: Kids love technology and they really enjoy watching videos. This always helps motivate them to learn more about a subject. The students will watch a short video daily throughout the unit. There are multitudes of videos for students to watch including the topic of Newton's Laws.

Studyjams.com offers six cartoon videos about each of Newton's laws and related vocabulary. Studyjams.com also includes a video about simple machines. Several of these videos offer a quiz at the end that you can be used as a fun way to wrap up, or as an assessment tool.

Another popular cartoon website with a lot of information for kids is Brainpop.com. Brainpop.com has ten videos that demonstrate Newton's laws and related vocabulary. At the end of each video is a quiz. The neat part of the quiz system on BrainPOP is that you can set it so it shows you the answer after each question, or to show you your results at the end of the quiz.

Discovery Education is another wonderful tool and website for educators. There are many videos to choose from and content is being added all of the time. Many of the videos also offer discussion questions. These videos are great for building background knowledge, introducing concepts, and providing further examples of a concept that students have already learned.

Culminating Project**:** To further my students' use of technology, they will actually make a video for their culminating project. Students will use Movie Maker which is on every one of my school systems computers to create their own movie that demonstrates each one of Newton's laws. Students can use pictures and actual video to create their product. The students can choose to narrate the film, or to provide subtitle throughout, explaining the visuals inside the video. Movie Maker is an easy application to learn and it only needs to be modeled once, and then the kids these days can usually take it from there! Some people think you need a fancy camera to do something like this, but these days the average cell phone, webcam, or digital camera have a very high quality video camera on them as well. These are almost always able to be connected to the computer for uploading images and video content. If you look around the classroom these days, more than likely, over half of the students have a camera sitting in their pocket!

Activities:

For the following activities, it will be important to have the students always use the Scientific Method. Always have them:

1. Form a question based on a problem.
2. Research and gather what you know.
3. Create a Hypothesis.
4. Test the hypothesis and experiment.
5. Analyze the data.
6. Communicate the results.

Students will use a ten foot section of plastic Race Track (Blu Track) to perform a series of four track activities demonstrating mass, speed, gravity, momentum, air resistance, friction, and acceleration by testing different types of Hot Wheels cars that either the teacher or students bring in. It may be interesting to create competition out of it and see who thinks they can bring in the fastest car, or slowest car and scientifically determine why each is the fastest/slowest. The teacher will need to make sure that there are at least a few pairs of identical Hot Wheels cars.

Activity 1: Gravity Race!

Objective: Students will explore the similarities/differences that the role of steepness plays on acceleration and speed. What steepness level will produce the fastest car?

Introduce the students to the Brainpop Videos: “Distance, Rate, and Time,” and “Acceleration.”

The Race Track starting point can be placed at different heights, allowing for changes in steepness. The steepness of the track helps determine how fast the cars go down the track. Although the gravity is not changing, steepness takes away the role that friction plays. Students will make predictions and hypothesize about what steepness heights will produce the faster speeds. Students will calculate speed by using the constant length(10 foot track) and finding the time in which it takes the car to go from start to finish. Speed is equal to distance divided by the time. Students can use a stop-watch to determine the elapsed time. Students will test each height multiple times and graph an average speed to compare against the next height. Students will draw conclusions about the effect that steepness has on the cars.

Activity 2*:* Momentum Breakthrough

Objective: Students will explore the factors that affect an object’s momentum. Which car has the most momentum and when?

Using the Race Track, students will test a variety of combinations of cars and momentum. Using various Hot Wheels cars, students explore a car’s momentum by having a bathroom tissue paper finish line (Have two students hold 1-ply bathroom tissue across the track.) at the five foot marker on the track. If a car has enough momentum, it will break through the toilet paper finish line. Describe what momentum is to the students and have them come up with various combinations to test, while looking for the following: They should test a bigger mass versus a smaller mass at the same speed [Steepness set up of the track (While technically the same speed cannot be confirmed due to the effects friction has on such small masses.)]. They should test a small mass at higher speed versus a larger mass at slower speed. These tests should allow the objects with more momentum to break through the toilet paper finish line, giving the students a clear view of what an object with more momentum is capable of.

Activity 3: Slow Down!

Objective: Students will test the effects of air resistance on a speeding car. What role does aerodynamics play in driving cars?

To test air resistance as a form of force, students will design spoilers for two identical cars. They should try to change the shape of the car in order to slow the car down to demonstrate the effects of air resistance. First test each set of identical cars to make sure they are going down the track at identical rates. If one is faster, you can still demonstrate the effects of air resistance by challenging the students to make the faster one become slower by changing it's shape. I like to drive home that we are only changing the shape of the car, while trying to keep the mass the same. Therefore, whatever we do to one car, we must add the same amount of mass to the other. For each set of identical cars give the students the following to add to their car: one inch of masking tape, two toothpicks, a half sheet of paper (4.25" x 5.5"). One student can simply tape the materials to the car to create an aerodynamic, faster car. The other student can create a huge spoiler that will catch wind and demonstrate the effects of air resistance on a moving object. It may be fun to have a contest of who can make the slowest cars using identical materials, and have a tournament!

Activity 4: Friction Reduction Racing

Objective: Students will test how friction affects the speed of a car. What is friction? When do you want more friction? When do you want less friction?

Discuss with students the reasons why friction is needed. We need friction to stop in when using the brakes in our car. We need friction in order for the wheels of a car to push against the road to accelerate. We need friction when speeding around a corner to keep us on the roadway. However, why would we need less friction? Well, to go faster of course! For this activity, test several cars multiple times and graph their average speeds like in the First Track Activity. Then, add a lubricant to the Hot Wheels such as a light oil or a graphite lubricant. Tell students that lubricants can reduce the amount of friction and allow the wheel and axle to spin freely, allowing the cars to go faster. Test the lubricated Hot Wheels cars in the exact same manner and watch the track speeds soar! Students can draw conclusions about other objects that could benefit from less friction.

Activity 5: Friction Fun

Objective: Students will determine what kinds of materials offer more friction than others. What would be a good material if you wanted more friction in stopping an object? How does friction relate to racing?

This activity also uses the Race Track. Students will test the friction of various materials sliding down the track. They will take a wooden block, and wrap it with different materials to test the friction of each. For each material, students will hypothesize whether they think the material will go downy the track faster or slower. For this experiment, I will have the ramp set up relatively steep so that no force is needed to set the wooden block in motion, other than gravity. This will help us keep the experiment valid. First, they will slide the wooden block down the block without any added material to obtain a control. Next, they will wrap a plastic bag around the block and slide it down the ramp. Then, they will wrap the wood block in rubber which I source from exercise bands that are commonly sold in sporting good stores and send it down the track. Finally, they will wrap the wooden block with sandpaper and test it. After the experimenting, they will use this information to draw conclusions about why certain materials are used in racing and general car use.

Activity 6: Keeping your Car in Park

Objective: Students will discover what inertia is: whether it is in motion or at rest.

Students should place a piece of notebook paper on their desk. Place a Hot Wheel car on top of the paper. Explain to students that all objects have inertia. All objects have the tendency to continue doing what they are doing. Currently, the car is at rest. It wants to stay at rest. Tell the students to pull the paper out from under the car as quick as they can. The object is to get the car to stay in place on their desk. Tell them that the only force that can cause the car to move is friction at this point. However, the mass of the object and gravity, cause the object to overcome the friction force we are applying to the object. Therefore, the object (more or less) stays at rest. It may wobble a bit, but will ultimately stay at rest. If we slow down the rate at which we pull the paper from underneath, friction seems to play more of a role in the situation and will actually overcome the object's inertia. Tell students that just as objects wish to remain at rest, they also have the tendency to keep moving when in a state of motion. The cars moving down the Race Track would keep traveling in the same direction, at the same speed, were it not for another force acting on them, usually friction and air resistance. Students are not usually quick to understand this concept, because their prior knowledge tells them that all objects come to a stop relatively quickly.

Activity 7: Crash Em' Up

Objective: Recognize that for every action, there is an equal and opposite reaction. What happens when a race car crashes into a wall?

Sure to be a class favorite. Have the students film what happens when a car crashes into objects. Have the students crash the Hot Wheels cars into various objects, filming the interactions. What they will notice is that when a Hot Wheels car crashes into a lighter object such as a pencil, the pencil will move. However, when a Hot Wheels car crashes into a concrete wall, the wall does not move. Encourage the students to conclude that even though, there is an equal and opposite reaction during these crashes, sometimes mass overcomes what we actually see. Challenge students to come up with more racing examples of Newton's Third Law. For instance, when the tires of a car push against the road, the road pushes back equally. Without this law, the car would simply peel out and would not be able to move forward. We need friction!

Activity 8: Lights, Camera, Action!

Throughout this unit, students will film their experiments. I will teach them how to use

Windows Movie Maker and/or IMovie to edit their video clips, to create a product that demonstrates all of Newton's Laws, as well as the key vocabulary they have learned along the way. The students will add captions, titles, and voiceovers to their video clips. The students will explain how and why Newton's laws are necessary in racing.

Additionally, students will create the video with the purpose of attaining a racing sponsor. This will cover a literacy standard of using a persuasive purpose. Tell students that they are trying to create a racing team. They can create a team name. They need to prove to the sponsors that they can create a great championship team by demonstrating their knowledge of Newton's Laws and all of the extensive vocabulary that they have taken notes on along through each of the activities. They can use each filmed activity, and provide voice-overs to explain the laws of force and motion, as well as convince an audience that they are capable of creating a championship team due to their knowledge of Newton's Laws. Students will explain that they know the role that friction plays, and how to overcome it in certain situations. They know the role of air resistance in creating faster cars. Students will then use persuasive vocabulary to try and convince corporations to "sponsor" their racing team.

Implementing District Standards

Each activity I have in this unit clearly allows students to demonstrate knowledge of the following Common Core Standards. The students participate in a variety of hands-on activities that allow them to develop an understanding of force and motion. They demonstrate this understanding by journaling, creating graphs, and drawing conclusions about Newton's Laws.

5.P.1 Understand force, motion and the relationship between them.

The sub-standards which fall under this are as follows:

5.P.1.1 Explain how factors such as gravity, friction, and change in mass affect the motion of objects.

5.P.1.2 Infer the motion of objects in terms of how far they travel in a certain amount of time and the direction in which they travel.

5.P.1.3 Illustrate the motion of an object using a graph to show a change in position over a period of time.

5.P.1.4 Predict the effect of a given force or a change in mass on the motion of an object.

Resources

Teacher Resources

Books

Pelecky, Diandra L.. *The Physics of NASCAR: the science behind the speed*. New York: Plume, 2009.

Everything you ever needed to know about the science that goes into NASCAR. Metals, combustion engines, sponsors, and everything in between.

Gardner, Robert. *Experimenting with science in sports*. New York: F. Watts, 1993.

This book gives a lot of great examples and experiments between Newton's Laws and sports.

Websites

"The Physics Classroom." The Physics Classroom. http://www.physicsclassroom.com/ (accessed November 25, 2012).

Animations and activity sheets to go along with many physics topics.

Student Resources

Books

Daniel, Lucy H.. *Macmillan/McGraw-Hill science*. New York: Macmillan/McGraw-Hill, 2005.

My classroom textbook and a great starting point that actually uses cars for many of the examples already.

Websites

"Welcome to Discovery Education | Discovery Education."Welcome to Discovery Education | Discovery Education. http://discoveryeducation.com (accessed November 25, 2012).

My school district gives all teachers access to this website. It has videos on all topics, as well as, review quizzes and other supplemental materials.

"BrainPOP - Animated Educational Site for Kids - Science, Social Studies, English, Math, Arts ."BrainPOP - Animated Educational Site for Kids - Science, Social Studies, English, Math, Arts . http://brainpop.com (accessed November 25, 2012).

This website is a pay-site. You can get access for an entire school and it is well worth it. It has a pair of hilarious animated characters that explain a wide variety of topics. It covers a brief history of scientists Gallileo and Isaac Newton. There are videos that teach about force, speed, gravity, and other physics topics. You can follow the video with a quiz that can be used for fun, or printed off for use as an assessment.

"StudyJams."StudyJams. http://studyjams.com (accessed November 25, 2012).

This website has great animated videos that demonstrate Newton's Laws and other physics related topics.

Classroom Materials

Appendix 1. Fasteners and track for the force and motion ramp kit.

Fasteners from McMaster-Carr

Line		Description
1	97008A616	Zinc-Plated Steel Spade Head Thumb Screw with Shoulder, 1/4"-20 Thread, 1" Length, packs of 25
2	96659A106	18-8 Stainless Steel Type A SAE Flat Washer, 1/4" Screw Size, 5/8" OD, .05"-.08" Thick, packs of 50
3	92001A321	18-8 Stainless Steel Wing Nut, 1/4"-20 Thread Size, 1-3/32" Wing Spread, packs of 25

Blu Track; Qty 1, Item #1100, description 30.48 Meters or 100 feet of BluTrack PRO (ON-LINE ONLY)

http://www.shop.blutrackpro.com/product.sc?productId=7

Appendix 2. Ramp Drawings

- The material we used was 16 gage Stainless Steel although regular sheet metal is fine.

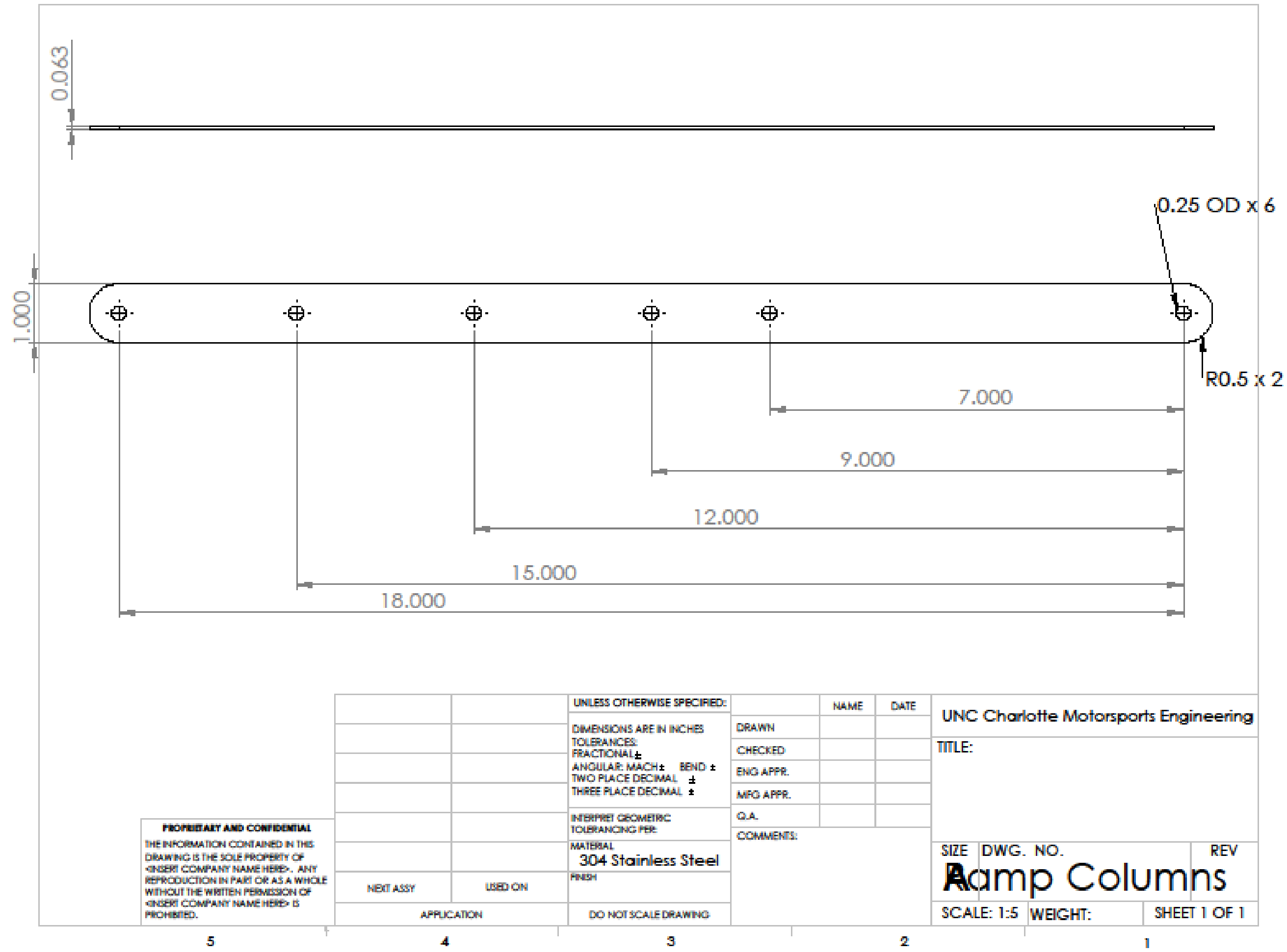
- We then cut the parts out, deburred them,and then polished everything.

- We used wing nuts for easy assembly; however, a ¼”–20 nut and bolt tighten just fine with fingers for this job.

- Our track was BluTrack:

  Qty 1, Item #1100, description 30.48 Meters or 100 feet of BluTrack PRO (ON-LINE ONLY)

  http://www.shop.blutrackpro.com/product.sc?productId=7


0.063
0.25 OD x 6
1.000
R0.5 x 2
7.000
9.000
12.000
15.000
18.000
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
304 Stainless Steel
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
UNC Charlotte Motorsports Engineering
TITLE:
SIZE
A
DWG. NO.
Ramp Columns
REV
SCALE: 1:5
WEIGHT:
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION
PROPRIETARY AND CONFIDENTIAL
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5
4
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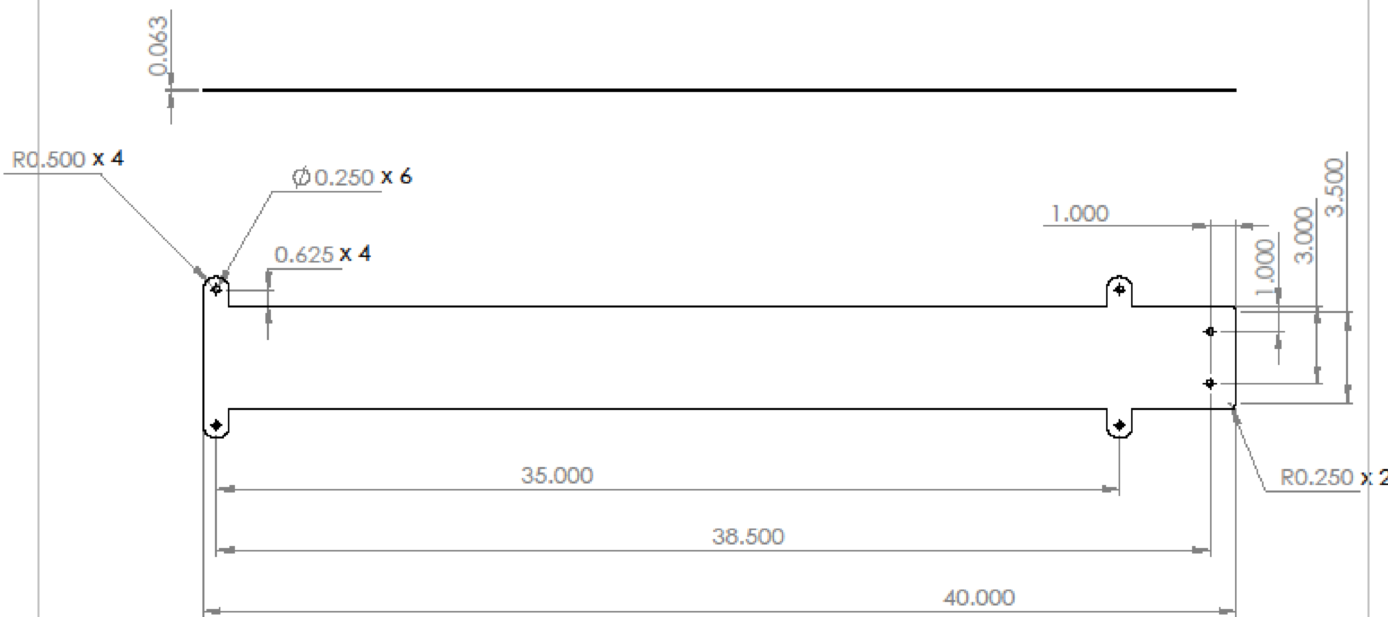

UNC Charlotte Motorsports Engineering

TITLE:

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MFG APPR.		
Q.A.		
COMMENTS:		

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL 304 Stainless

FINISH

DO NOT SCALE DRAWING

NEXT ASSY	USED ON
APPLICATION	

PROPRIETARY AND CONFIDENTIAL

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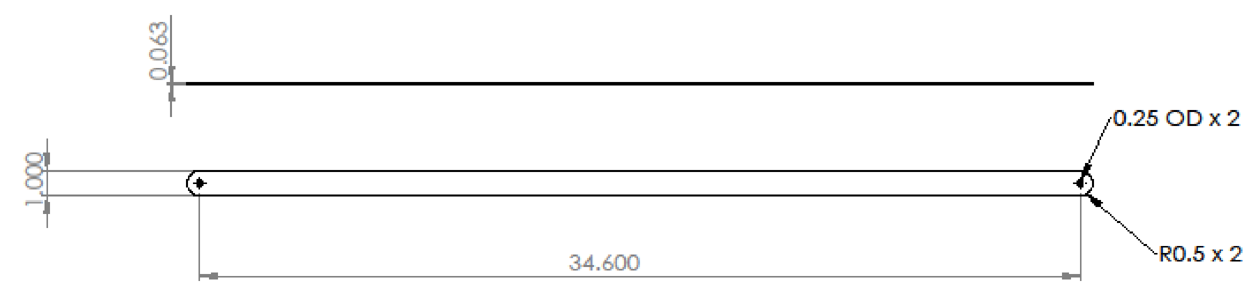
SIZE A | DWG. NO. Ramp | REV

SCALE: 1:10 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1



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NEXT ASSY | USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC TOLERANCING PER:

MATERIAL
304 Stainless Steel

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:

UNC Charlotte Motorsports Engineering

TITLE:

SIZE A | DWG. NO. Ramp Base | REV

SCALE: 1:10 | WEIGHT: | SHEET 1 OF 1

5 4 3 2 1

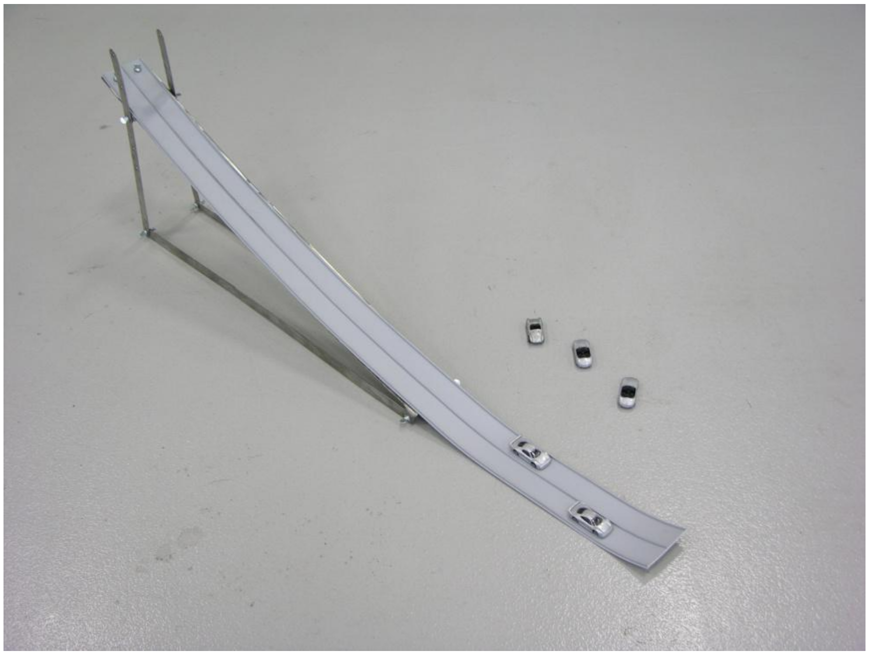

Figure 1. The ramp as used. This ramp and the diagrams attached were developed by Peter Tkacik from the UNC Charlotte Motorsports Research Department and a team of teachers from Charlotte Mecklenburg Schools in North Carolina.

Notes

(1) Swanson, Christopher. "Who Graduates? Who Doesn't?: A Statistical Portrait of Public High School Graduation, Class of 2001." The Urban Institute | Research of Record. http://www.urban.org/publications/410934.html (accessed November 11, 2012).

(2) Levinson, Meridith. "A Brief History of Nascar: From Moonshine Runners to Dale Earnhardt Jr. CIO.com." CIO.com. http://www.cio.com/article/17142/A_Brief_History_of_Nascar_From_Moonshine_Runners_to_Dale_Earnhardt_Jr. (accessed November 11, 2012).

(3) "NASCAR.COM - History of NASCAR - Jul 17, 2008." The Official Site of NASCAR News, Video, Drivers, Tracks, Schedules & Fantasy | NASCAR.COM. http://www.nascar.com/news/features/history (accessed November 11, 2012).

(4) Erwin, Jill. "The cost of competing - Apr 06, 2011 - NASCAR.COM." The Official Site of NASCAR News, Video, Drivers, Tracks, Schedules & Fantasy | NASCAR.COM. http://www.nascar.com/news/110406/nationwide-costs-economy/index.html (accessed November 11, 2012).

(5) Hall-Geisler, Kristen. "HowStuffWorks "How a NASCAR Sponsorship Works"." HowStuffWorks "Auto". http://auto.howstuffworks.com/auto-racing/nascar/nascar-basics/nascar-sponsorship.htm (accessed November 11, 2012).