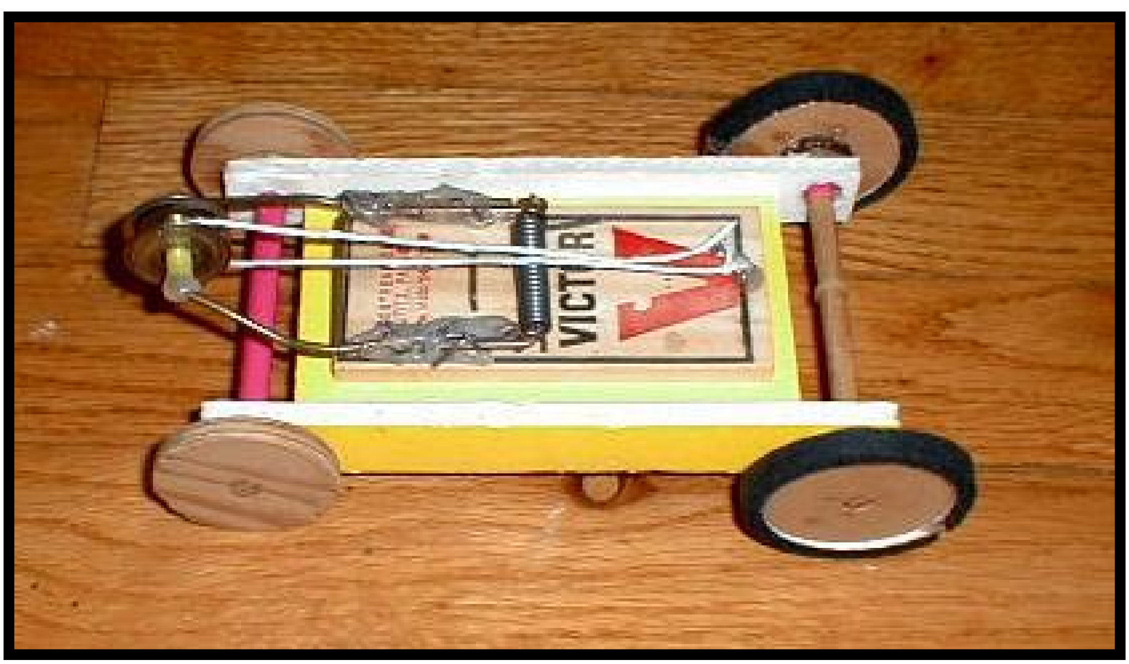
George the Mouse Trap Car



Purpose:

The purpose of this project was to build a fast car made from wood or foam board that uses a mouse trap for an engine and power. And our car (a speed car) needed to go 4 meters in under 3 seconds for an A, 3 meters in under 3 seconds for a B, and so on. When we were timed for a grade, our car, named George, went 4 meters in 2.04 seconds, so we got an A.

How a Mousetrap Car Works:

The car works by string wrapped around the axle being pulled by the mouse trap springing, causing the axle to spin and the car to move. For the car to go really well, you need to have little or no friction between the axle and the hole it goes through, so that the wheels spin freely, and then the car will go really far and fast. Another thing that will help to make your car perform better is if you have plastic or metal axles so you can grease them, which significantly improves your car's performance.

Procedure:

- ## Initial design

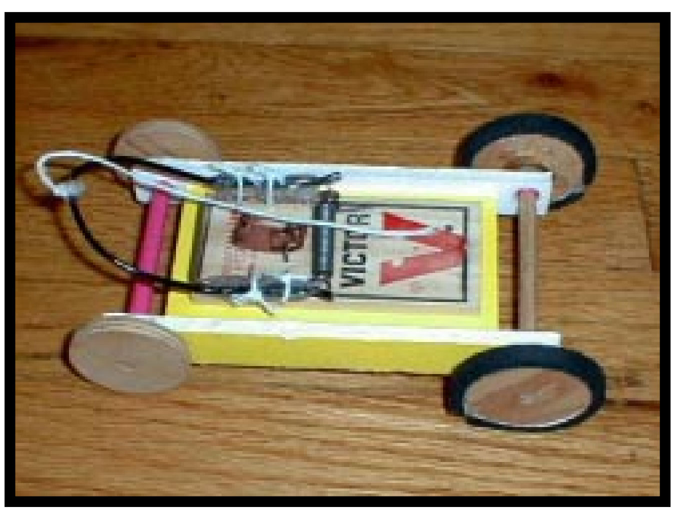
Our first idea was to build our mouse trap car's body out of wood to make it sturdy, but when we got it done it was too heavy. We made the wheels out of wood using a hole saw to make sure they were round and even, but the wheels didn't have enough traction so the car spun out. We made the axles out of a dowel rod. And we had string to attach to the mouse trap and the axle but when we just wrapped it around the axle, it slipped on the axle when the mouse trap sprung. It slipped on the axle because there was not enough friction between the string and the axle.

This caused the car to only go a few inches. When we used a longer string to get more friction, it quit unwrapping when the mouse trap was done springing, and then it made the axle quit spinning and stopped the car. So that didn't work either. Also there was too much friction between the wooden axle and the wooden holes in the body. So we had to revise the design.

- **Design Rev. A**

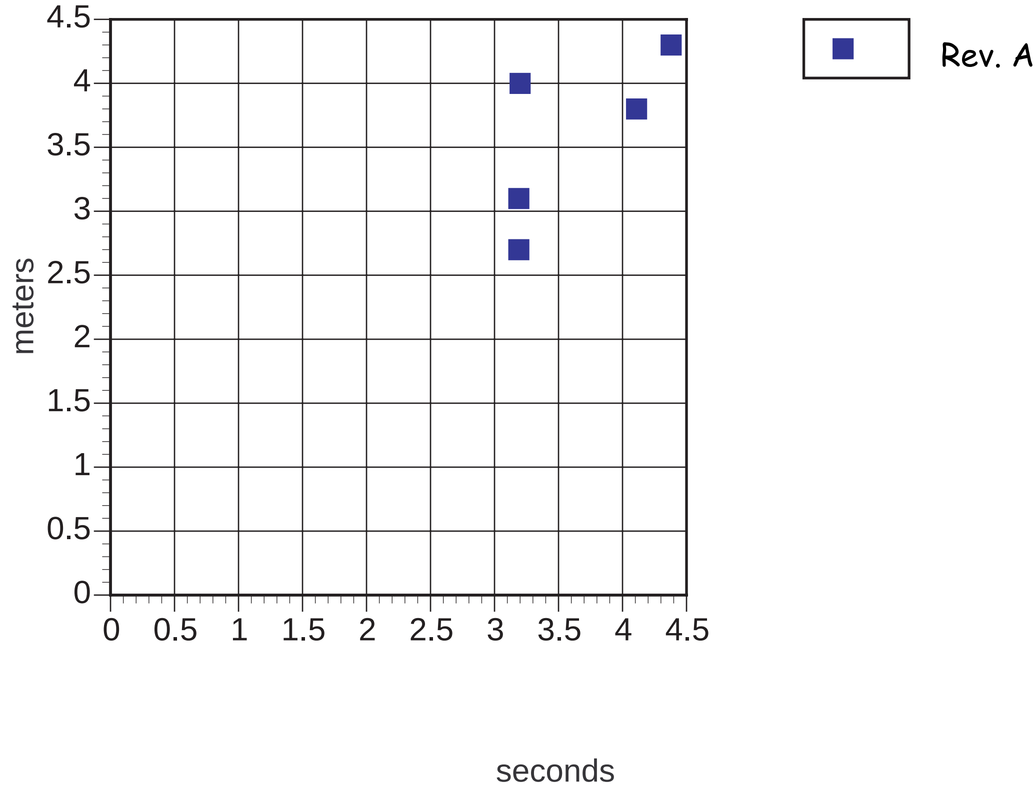
We changed the body from wood to foam board, because foam board is lighter than wood, and because then the car doesn't have to pull as much weight, so it will go farther and faster. We added tires because the car was spinning out, so we would get more traction. We added the lever arm extension because then you increase the amount of string wound around the axle, so you put more force into the axle, so it twists more so the car goes farther and faster. We added plastic straws slid over the axles in the parts where it went through the axle holes, to reduce friction, and also then we had a smooth surface that we could grease later to reduce the friction even more. We reinforced the axle holes in the foam board body with washers because this gave us nice smooth holes for the axles to turn in.

Also we put a piece of Scotch tape to hold the string to the axle so it wouldn't slip, but it would let go when the mousetrap sprung, because the string was short enough to pull free, so it wouldn't slow the car down.



We made these changes because our first car hardly went anywhere, and the wheels were spinning out and needed more friction. The Rev. A car went a lot better than the initial design, so we did some trials to see how it was performing.

Performance tests:



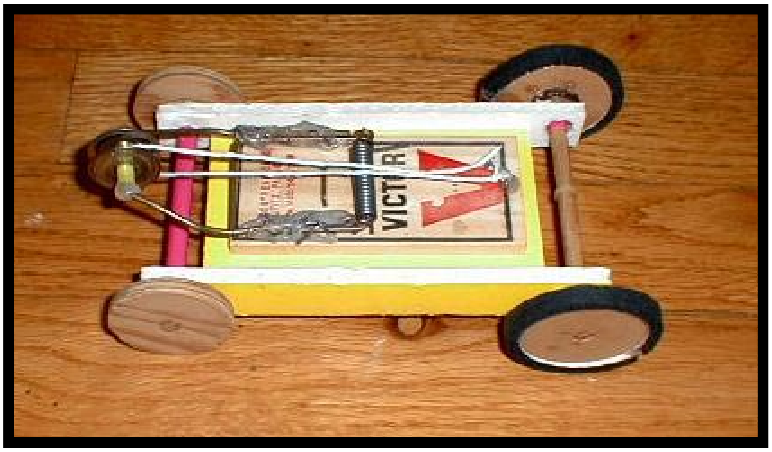
We did five trials on the hardwood floor in the basement with a stopwatch and timed the car until it stopped, and measured how far it went until it stopped. The car went an average of 3.5 meters in 3-4 seconds. And this was much better than the first car.

But we still thought that it needed some improvement.

- ## Design Rev. B

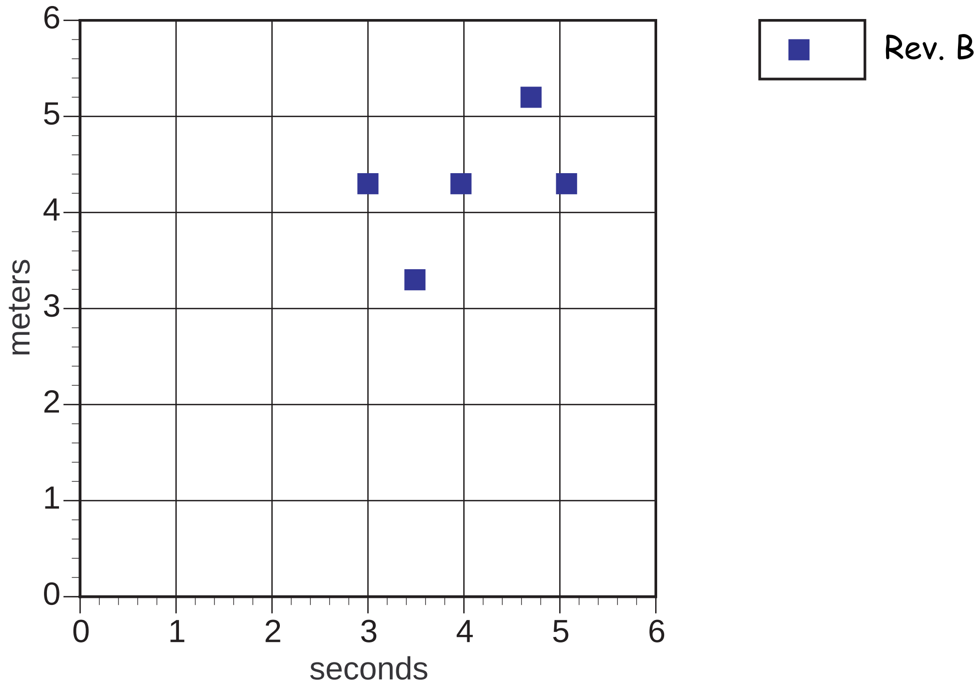
The Rev. B was different from the Rev. A, because we added a pulley onto the lever extension to double the length of string used, which would double the amount of power delivered to the axle. The pulley was made of a sewing bobbin.

Also we replaced the Scotch tape that held the string to the axle with an orthodontic rubber band because it was easier to use.



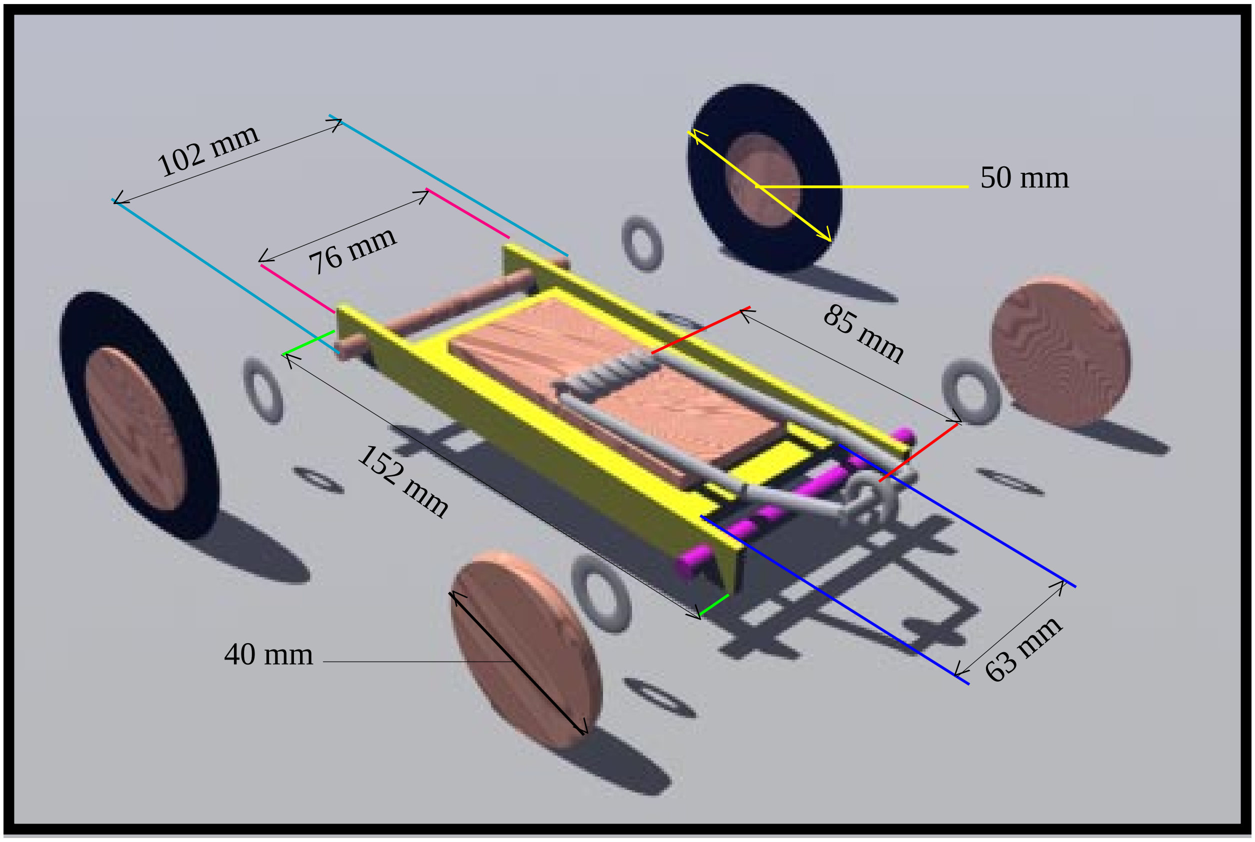
Then we did some performance tests again.

Performance tests:

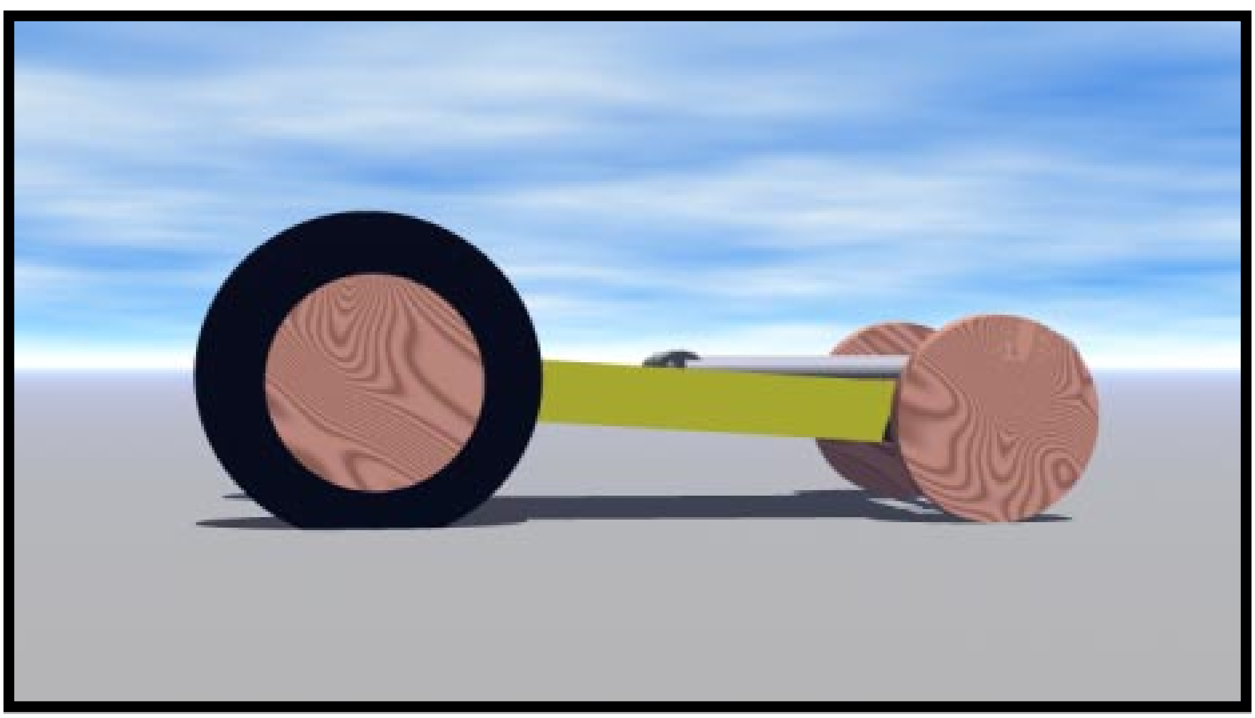


The car went about an average of one second longer before it stopped, and about one meter farther. This was good progress and close to our goal.

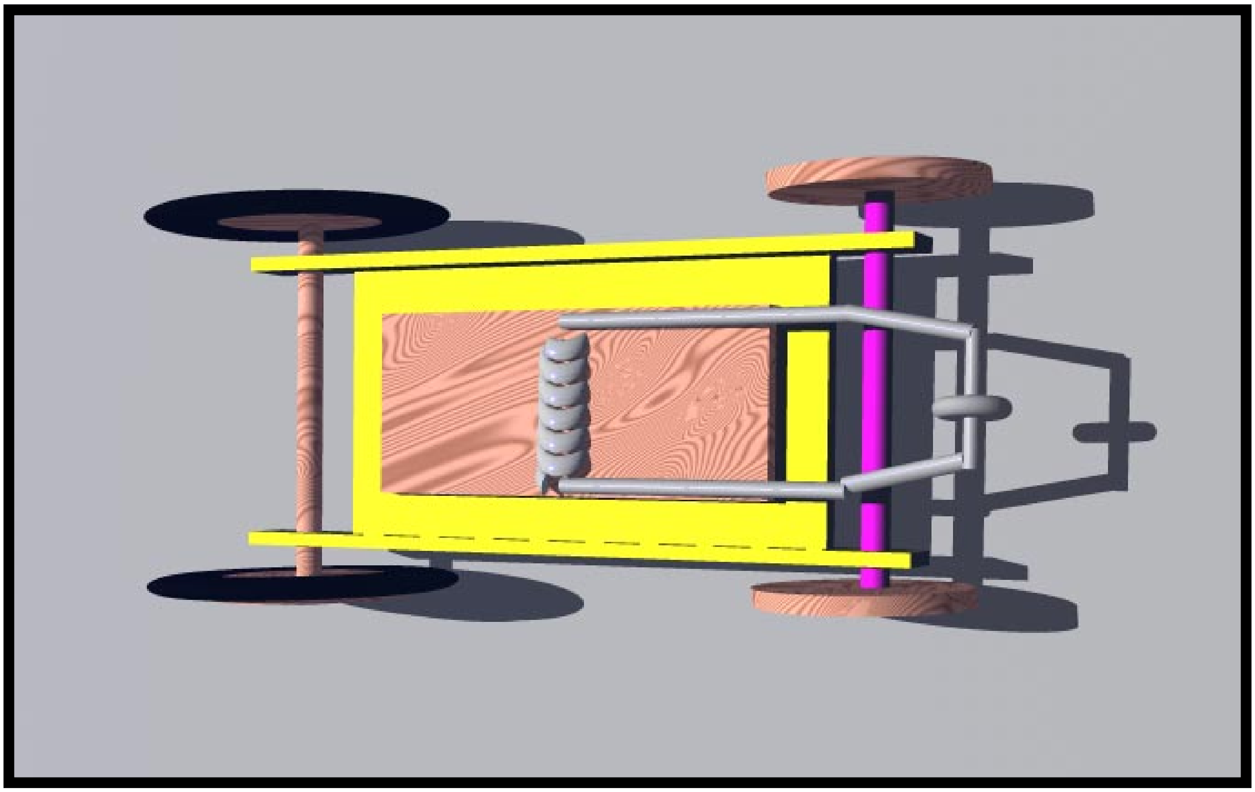
Final Design:



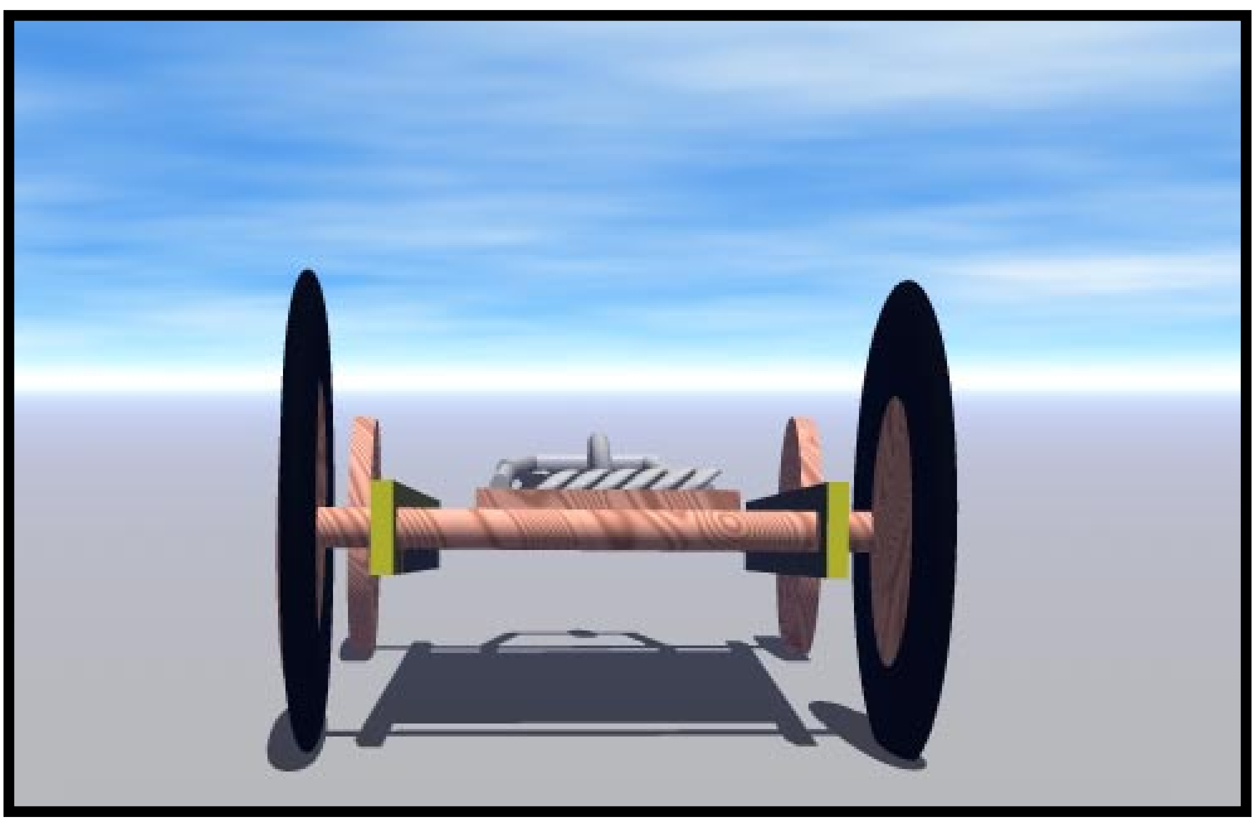
Exploded oblique view



Side view



Top view

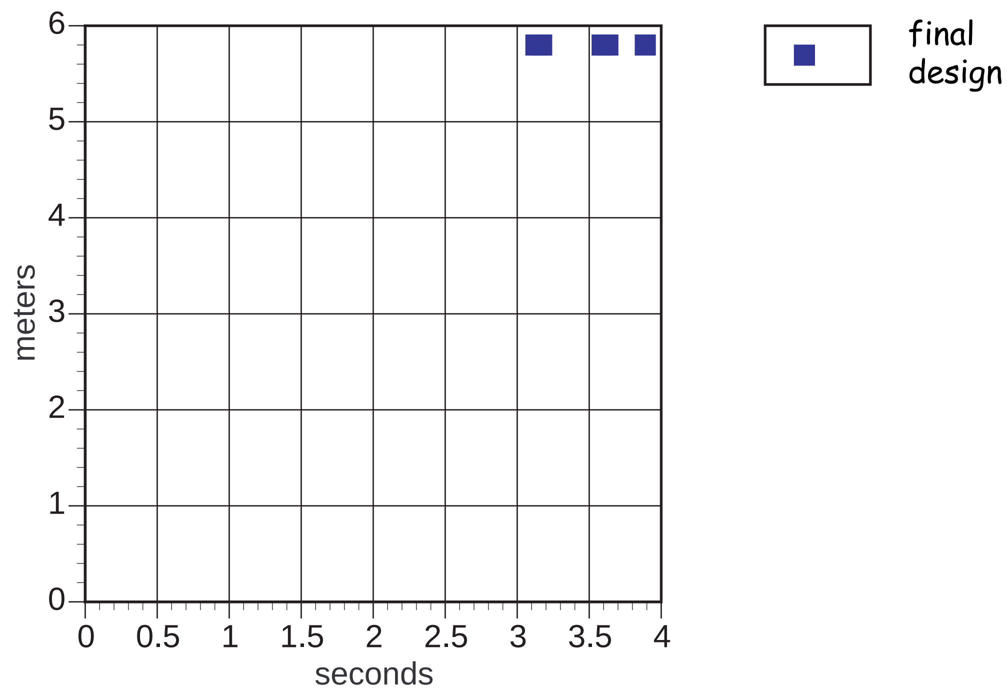


Rear view

Finishing touches—the "secret weapon":

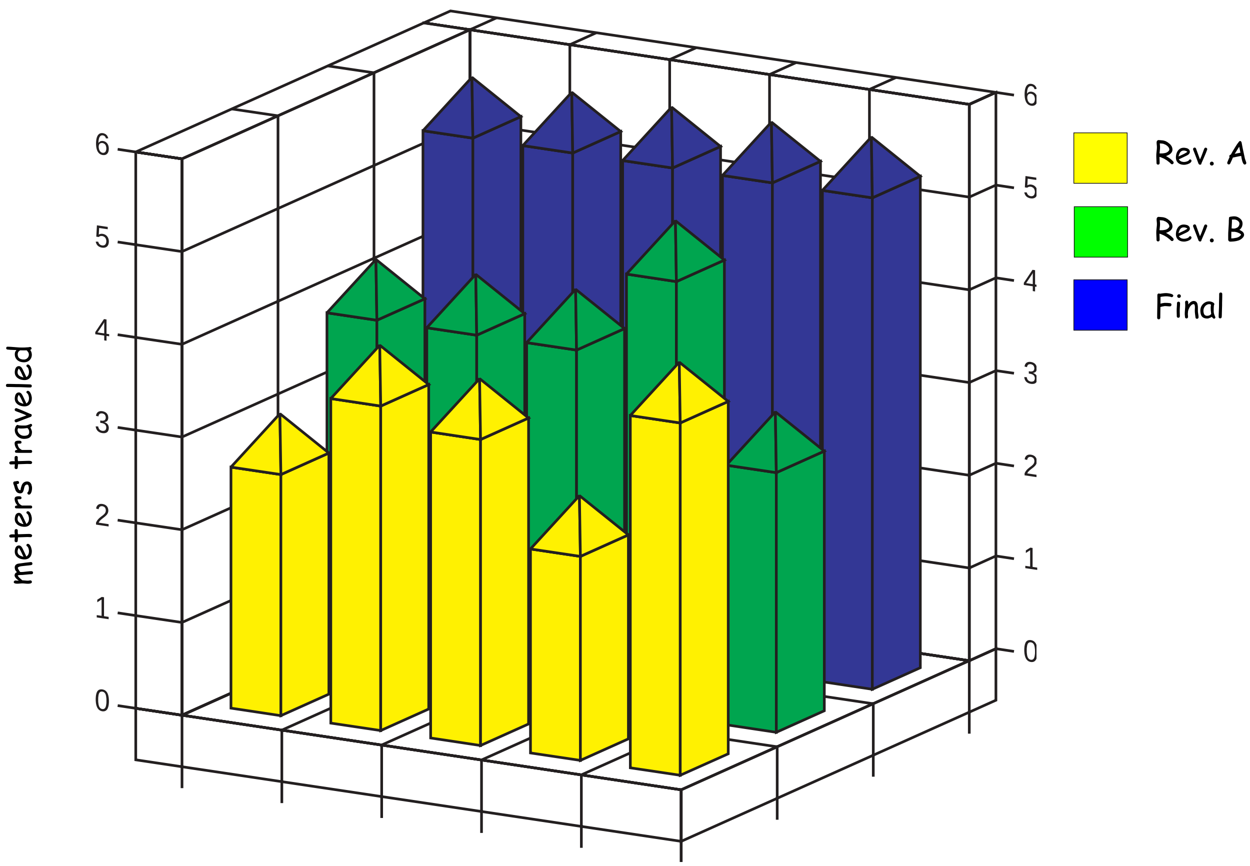
The Rev. B car was pretty close to the requirements for an A on a speed car, but needed a little boost. So we greased the axles where they went through the holes in the body, and also the washers on the body that made the axle holes. This was to reduce the friction between the axles and the body. We put Crisco on a Q-tip to do the greasing because we wanted to keep the grease on the pink plastic straws on the axles, and not get any on the wooden part of the rear axle, because there we needed friction with the string. Also we didn't want to get our car all slimy. Then we ran our performance tests again.

Performance data:



Now George really zoomed. The graph shows that it went 5.8 meters every time. Yes, they are all really 5.8 meters. They are all 5.8 meters because that was the limit before it hit the wall. And if there had been more room the car would have gone farther. It went almost 6 meters in 3-4 seconds so we were pretty sure that it would meet the speed car requirements of going 4 meters in 3 seconds or less, even though we didn't actually measure that at home. We think it was because the Crisco made it so the wheels would turn easier and faster. So we decided we were now done with our car.

When we tried our car at school for a grade, it went around 8 meters before it stopped, and went 4 meters in 2.04 seconds.



Comparison of performance data

This graph shows how George's performance improved as we made the changes to the design.

Questions:

1. Identify the simple machines in your mouse trap car.

The simple machines located on our car are a pulley (the sewing bobbin), a lever (the wire part of the mouse trap, including the wire extender), four wheels, and two axles which are a type of wheel.

2. Identify all points of friction in your mouse trap car.

The main points of friction in our mouse trap car are between the axles and axle holes (washers), between the wheels and the body, and between the wheels and the floor. And of course there is friction between the string and the axle (helped by the rubber band), otherwise the axle would not spin and the car would not go. There is also a little bit of friction between the string and the pulley and between the pulley and the wire it spins on, but not very much.

3. Explain why you chose large or small wheels.

We chose smaller wheels because we wanted a speed car, and a speed car needs small wheels to go fast. A speed car needs smaller wheels because smaller wheels exert more backward force on the ground, and the more backward force there is against the ground, the faster the wheels will spin. So a car with small wheels is more likely to spin out, which is why we needed to add the tires.

4. Use the equation for work (work = force x distance) to explain the position of your trap and the length of your lever.

The mouse trap is located where it is because we needed to make the car smaller to reduce the weight. The work done by the lever on the mouse trap depends on how far the lever travels when the trap is sprung. We made the lever in our car longer, so it would travel twice as far and do twice as much work, so we would get more revolutions of the axle, to make the car go farther and faster.

5. How does Newton's 1st Law of Motion apply to your car?

The car stays at rest until acted on by the force of the string pulling on the axle, which makes it go. The car stays in motion until friction has acted on it to stop it.

6. How does Newton's 2nd Law of Motion apply to your car?

Newton's 2nd law of motion applies to our car because the mass comes from the wheels, body, and mouse trap, and the force comes from the lever on the mouse trap. The force acting on the mass makes an acceleration. So it goes.

7. How does Newton's 3rd Law of Motion apply to your car?

Where the tires touch the floor they exert a backward force on the floor, so the floor exerts a forward force on the wheels, and the car goes forward.

8. What changes did you make to your car to improve its performance?

The changes we made to make our car have better performance are we changed the body to foam board, we added an extension on the lever, we put tires on the wheels, we added a pulley, and we added Crisco to make the wheels turn easier.

9. What would you do differently next time?

We would do nothing different because it goes very well.

10. Calculate the velocity of your car.

The velocity of our car is 1.96 m/s.

11. Calculate the momentum of your car.

George weighs 84.1 grams, so the momentum of our car was 164.8 g-m/s.