

## Car Design

### INTRODUCTION

In weeks we have been working to make space to build a car for our physics project. The process involved us in testing, and analyzing a car. We utilized the application, Fusion 360, to design our car, and the maker space in order to achieve this.

For the size, we were only allowed a 4cm by 9cm rectangle in which our car must fit in. We were a bit smaller than that at 22.5 millimeters wide and 25 millimeters, mainly due to the shape of our design. In order to reduce the mass of our car as much as we could, in order to allow for it to travel far, in terms of material, we were given two batteries in which we had to use to power our car, and because two batteries did not provide a lot of either wood or plastic, and we chose plastic, due to its lightweight, flexible properties that we wanted for our car.

### DESIGN PROCESS

**#1. Selection**  
Our battery slots proved to be the most challenging part of getting our car to move. Because our battery slots were not big enough, our car would not run due to an unstable connection between the battery and the wire. We ended up changing the dimensions of the battery holder to allow for a more stable connection. The first time our car only travelled for approximately a meter, however with a new battery holder our car went 4.5 meters.

**#2. Data Collection**  
When fully charged, two batteries allowed our car to run a total of 4.5 meters over the course of around 5 seconds.

**#3. Motors, Wires, and Batteries**  
We used a parallel circuit for the wiring to enable both wheels to spin with the same amount of energy in a parallel circuit, the flow of the electrons are unaffected by the other pathways in which they flow, and each motor gets the same amount of voltage as a result. If we used a series circuit, the energy would not be evenly distributed amongst both wheels, as one would be getting the majority and the other the minority, which would result in our car spinning in circles. Therefore, we needed to use a parallel circuit to ensure the greatest efficiency for our car.

**#4. Battery Slots**  
We used Fusion 360 to design a base with two vertical slots for our batteries and empty space for the wire connections. The slots needed to be large enough to fit the battery and the wire, but small enough so that the wire could touch the battery with a stable connection. We ended up with the dimensions of 22.5 millimeters deep.

**#5. Free!**

To calculate the force of our car, we used Newton's and law  $F = m \cdot a$ .

mass = 0.12465 kg  
acceleration: 0.12039  
 $0.12465 \cdot 0.12039 = 0.015012$

To find the acceleration we had to find the velocity of our car, which was measured by distance/time (m/s).

$F = m \cdot a$   
The x axis represents the distance our car traveled, and the y axis represents the time taken (seconds).

We then used the velocity to find the acceleration, which is measured in change in velocity over change in time (m/s<sup>2</sup>).

The x axis represents the velocity of our car, and the y axis represents the time taken (seconds).

Thus the total force acting on our car is 0.015012 newtons. (Newton = kg \* m/s<sup>2</sup>)

Our car has a mass of 0.12465 kg. With the force of 0.015012 N, the acceleration is 0.12039 m/s<sup>2</sup>. According to the action has an equal and opposite force of 0.015012 N.

As previously calculated, the force of 0.015012 N exerts an equal and opposite reaction on the car and the car.



**Driving Question:** How do we design and build an electric car?

### Project Description:

Students investigate physics and engineering principles to work in teams to design a car powered by electricity. Students used software fusion360 to design a car to print or cut from wood, predict the energy from two lithium-ion rechargeable batteries, power the car with the batteries connected to two motors then analyze the actual car motion with video analysis to determine the forces acting on the car.

## Student Products

- ▶ Design of an electric car as well as working prototype
- ▶ Data analysis of various tests and experiments
- ▶ Poster presentation of process, product and learning

## Student Reflections

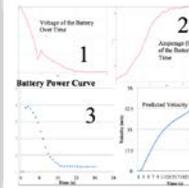
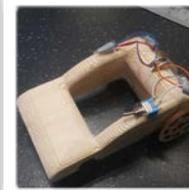
"Throughout the entire process of designing and finally making a car, there were many obstacles for us to overcome. We had some big issues with the wiring, with accidentally burning one of the motors being one of the biggest problems. It took us quite a long time to get the wiring correct, as it was very hard to properly solder everything together properly. There was also some disagreement between us when we were designing our car, because one preferred aesthetics over function, whereas it was the vice versa for the other. This made our design process a little longer than it should've been, but we are both happy with the final product." - John and Steve

"I like how we could mess around with our design and thoroughly use the maker space." - Amanda

"When I was first introduced to this project, I didn't know how to react. There was so much to do, and so little I knew at the beginning. But then I started to gradually learn more through the videos and chats with teachers." - Brandon

"I had always been entered in electric cars and that interest developed even more after this project." - Nicolas

"Our car underwent various stages of improvement. For the first few weeks our car barely moved due to wiring issues with the motors and switches. We experienced two failed switches and one failed motor that slowed down our process... The final times we made the battery holder slot smaller so that our wires and batteries would press firmly against each other, and our car was able to travel for a full 4.5 meters before the battery ran out of charge." - Naomi and Iris



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