The Effect of Wheel Material on the Speed of a DC Motorized Toy Car

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What did you do?

My project tests how different wheel materials affect the speed of a DC motorized toy car. I built three identical cars, but each car had a different wheel material: steel, wood, or rubber. I raced each car four times on the same track and measured the time it took to reach the finish line with a stopwatch.

Why did you choose this project?

I chose this project because wheels are used in many everyday things like cars, bikes, and trains, and I wanted to understand how friction affects how fast they move. My project tests how different wheel materials affect the speed of a DC motorized toy car. This project shows how engineers think about friction when designing wheels for different uses.

What did you expect to happen?

I expected the steel and wood wheeled cars to go the fastest because these materials are hard and smooth, which should create less rolling friction with the track. However, steel will go faster than wood because it has the smoothest texture and the least amount of friction. I thought rubber wheels will be the slowest because it has more surface texture and will have the most rolling friction force against the wood track.

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Experimental Design

Three identical DC motorized toy cars were built using the same type of DC motor, wooden axles, nylon rim, batteries, and battery holder. The only difference between the cars was the **wheel material**, which served as the independent variable. The three materials tested were **steel, wood, and rubber**.

A straight test track was built using a wooden board with plastic straws as side rails to guide the cars. A starting line and finish line were marked to keep each trial consistent. Each car was placed at the same starting position and released using the same procedure.

Each car was tested four times, and a stopwatch was used to measure the **time it took for the car to travel from the starting line to the finish line**. The times from each trial were recorded and compared to determine how wheel material affected the speed of the motorized car.

All other factors, such as the motor type, battery power, track surface, and starting position, were kept the same to ensure a **fair test**.

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Variables

Independent Variable (What I changed):
The wheel material used on the toy car (steel, wood, or rubber).

Dependent Variable (What I measured):
The time it took for the car to travel from the start line to the finish line, which shows the car's speed, recorded in seconds.

Controlled Variables (What I kept the same):
- Wheel diameter (1 inch)
- Motor type (DC 3V)
- Battery and power source
- Car design
- Track surface and length
- Starting position
- Testing procedure

Uncontrolled Variables
- Weight of cars (steel 110g, wood 98.6 g, rubber 102.1 g), wire connection, human error with stopwatch

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Data (Tabular Form)

Wheel Material	Trail 1	Trial 2	Trial 3	Trial 4	Average Time
Steel	0.74 s	0.63 s	0.58 s	0.51s	**0.62 s**
Wood	0.85 s	0.73 s	0.73 s	0.83 s	**0.79 s**
Rubber	1.05 s	0.96 s	1.01 s	1.0 s	**1.01 s**

My results showed that the steel wheels were the fastest with its average speed at 0.62 seconds. The wood wheels were second, with an average speed of 0.79 seconds. The rubber wheels were the slowest, with its average speed at 1.01 seconds.

In all four trials, I noticed the rubber wheels took longer to pick up speed, after it was dropped on the track. This happened because elastic materials like rubber, create more rolling friction with the wood track, which slows the car down.

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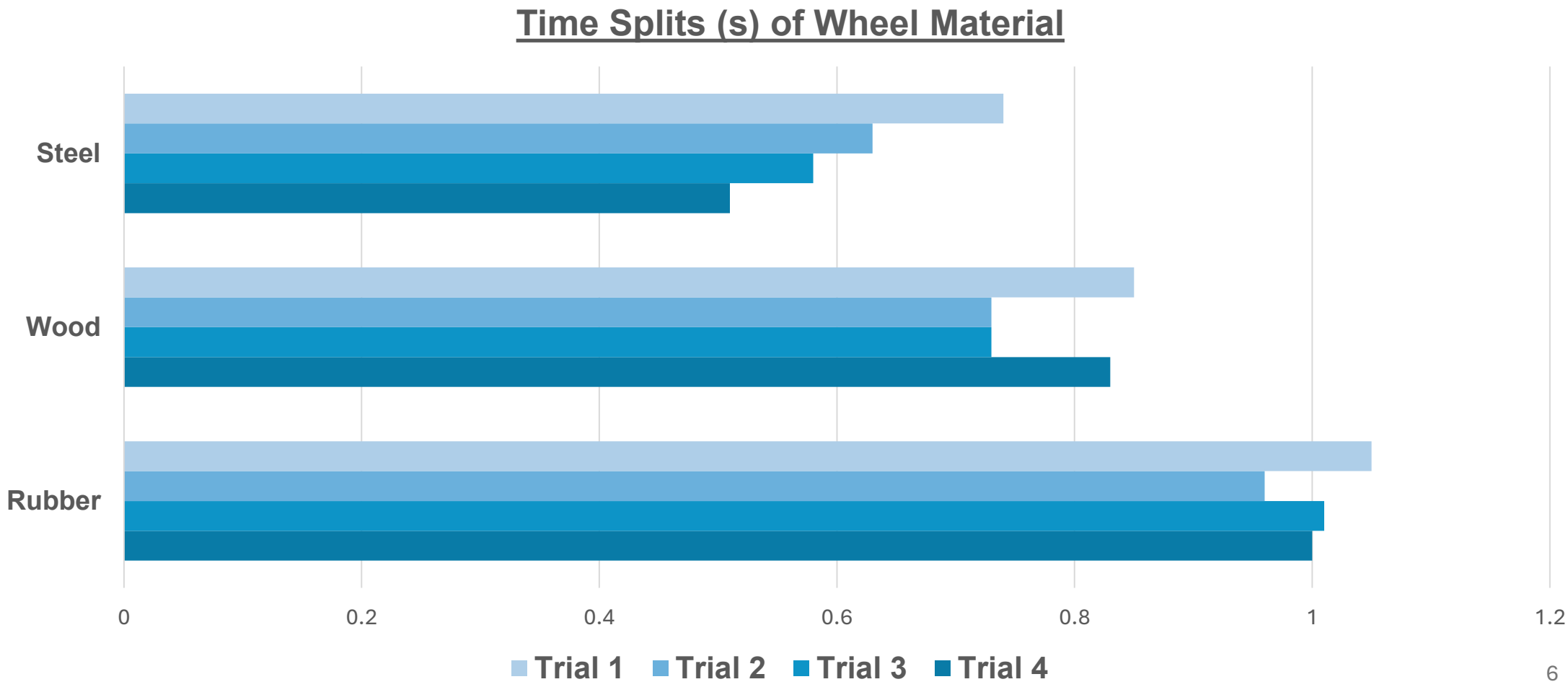
Data (Bar Graph Form)



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Data Analysis

After completing the trials, I recorded the time for each car to travel from the starting line to the finish line. Each wheel material was tested **four times**. I compared the times from each trial and calculated the **average time** for each type of wheel.

The results showed that the **steel wheels had the fastest average time**, meaning this car moved the fastest. **The wood wheels had the second fastest time**, and the **rubber wheels had the slowest time**. This pattern appeared in every trial, which suggests that the wheel material did have an effect on the speed of the car.

Reliability of Results

My results are reliable because I repeated each test four times and the results were consistent across the trials. I also kept other factors the same, such as the design of the cars, the same wood track, stopwatch, and starting position, so that the **wheel material was the only variable that changed.**

Testing multiple times helps reduce changes in the results caused by uncontrolled variables. Because the same pattern appeared in each trial, I can be more confident that **wheel material truly affected the speed of the car.**

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Meaning of Results

The results show that **wheel material affects how fast a motorized toy car can travel.** The steel wheels consistently had the fastest times, followed by the wood wheels, while the rubber wheels were the slowest. This suggests that harder materials allow wheels to roll more easily because they create **less rolling friction** with the surface of the track.

Rubber wheels moved slower because rubber is elastic and deforms when it touches the track. Rubber must regain its shape after this deformation and loses kinetic energy in the process. This increases friction and caused the rubber wheels to move slower. Steel wheels are rigid and deform less, which allows them to roll more efficiently.

The data **supports my hypothesis**. I predicted that harder wheel materials would make the car travel faster because they produce less friction. The experiment showed that the steel wheels were the fastest in every trial, which matches my prediction.

These results help demonstrate how friction affects motion and show why engineers consider material choice when designing wheels for vehicles and machines.

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Next Steps and Applications

If I continued this experiment, I would test **additional wheel materials** such as plastic, aluminum, or different types of rubber. I would also test the cars on **different track surfaces**, like carpet, sandpaper, or smooth plastic, to see how the interaction between the wheel and the surface effects speed. Another improvement would be to use a digital timer or motion sensor to measure speed more accurately.

Another variable I would have liked to investigate is changing the **diameter of the wheel**, to test the speed of the cars based on a larger diameter wheel.

The results of this experiment can apply to real-world transportation and engineering. Engineers must consider friction and wheel materials when designing vehicles such as cars, bicycles, trains, and robots. Choosing the right materials can help vehicles **move faster** and **use less energy**.

Understanding rolling friction can also help improve the efficiency of machines used in factories, warehouses, and transportation systems. By reducing friction, engineers can design systems that move more smoothly, save energy, and perform better.

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Bibliographic References

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University of Physics with Modern Physics 14th Edition, Hugh Young, Pearson Pub Ltd., 2010

https://nationalmaglab.org/magnet-academy/ (How a DC Motor Works)

https://www.youtube.com/watch?v=qymG8w4ZIpE (How to Make a Powered Car Very Simple - DIY Electric Mini Car) Mini Gear Channel

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Project Pictures: