CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
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Project Number
S0222

Project Title
The Effect of Gear Size on a Spring-Powered Vehicle

Abstract

Objectives/Goals
The purpose of this project was to find the optimum gear ratio for a spring-powered vehicle, by testing it repeatedly and finding the average velocity achieved by each gear. We tested a 7.62 cm (3-inch) diameter drive shaft with a 10.16 cm (4-inch) diameter gear, 7.62 cm diameter gear, and a 5.08 cm (2-inch) diameter gear.

Methods/Materials
This vehicle was constructed primarily from 1-inch diameter PVC pipe. #T# connectors and glue hold the pipes together, and the wheels are mounted on lag screws driven into wood dowels rooted in the PVC pipe. The motor itself is a winch. Two bungee cords are attached to a 7.62-cm drive shaft. When the bungee cords are tightened, then released, the drive shaft turns a gear, which winds a rope attached to a stationary object. Therefore, the vehicle pulls itself along the rope, much like a cable car.

We test each gear with the vehicle, 5 times each to ensure accuracy. The vehicle travels 12 meters, and we record the time it took to travel the 12 meters. The gear setup that propelled the vehicle at a higher average velocity is considered the most effective.

Results
The 4-inch gear achieved an average velocity of 4.688 meters/second, while the 3-inch gear achieved an average velocity of 4.364 meters/second. The average velocity of the 2-inch gear was 4.149 meters/second.

Conclusions/Discussion
The test results confirmed our hypothesis. Although the two-inch and three-inch gears rotate faster, thus accelerating faster, the four-inch gear winds more rope with each turn, consequently achieving a higher top speed. This is crucial during the last five meters of the run, because once the vehicle travels roughly seven meters, the motor no longer produces enough torque to keep the rope taut, subsequently causing the winch to stop winding. Therefore, the vehicle travels the last five meters due to momentum. Since momentum equals mass multiplied by velocity, expressed as p=mv, the vehicle with the greater velocity will have a greater momentum. With more momentum, the vehicle would have a higher tendency to retain its state of motion, thus retaining its top speed for a longer time. Due to this fact, the vehicle with a greater momentum would have a greater average speed, in this case, the vehicle with the four-inch gear.

Summary Statement
We tested a spring-powered vehicle with three different gear sets, and found which gear setup propelled the vehicle 12 meters at a higher rate of speed.

Help Received
Uncle assisted in using drill press for axle holes