CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

Kate E. Jackson

Project Number

35306

Project Title

Demonstrating Doppler: Determining the Speed of an Object with Sound

Abstract

Objectives/Goals

I want to find out if the Doppler Effect can be used to measure the speed of a toy car with a buzzer mounted on top. I found in my research that Doppler's formula relates the change in pitch to speed. I expect that when the car is moving towards the microphone the pitch of the buzzer will sound higher. I also expect that the pitch of the buzzer will sound lower when the car is moving away from the microphone. My project is to show that I can use Doppler's formula to accurately measure the speed of the toy car.

Methods/Materials

I set up an experiment using a loud buzzer mounted on top of a toy car. I slid the car down a sloped track so the car could gain momentum and have speed. I used a microphone and oscilloscope to measure the wavelength and frequency of the buzzer sound emitted by the car standing still. I then repeated the sound measurement with the car moving at top speed past a trigger at the base of the hill. I used Doppler's formula to calculate the speed of the moving car from my still and moving frequency measurements. I needed some way to find the true speed of the car to compare with my Doppler measurements. I purchased a photogate sensor, which measures the time it takes the car to pass through a gate and converts that time to speed. I measured the car using Doppler and the photogate at three different speeds moving forward and backwards relative to the microphone. For each of these six tests, I repeated the measurement five times for a total of 30 measurements in all.

Results

My results showed a clear increase in pitch with the car moving towards the microphone and a decrease in pitch with it moving away. All of my Doppler results matched the photogate speed with less than ten percent error. The average error in the forward direction was 1.2%. The average error in the reverse direction was -1.6%.

Conclusions/Discussion

My hypothesis was that I could accurately measure speed using the Doppler Effect. "Accurate" is a broad word. I think that my results are not exact, but an average error of less than 2% and a peak error of ten percent seem reasonably accurate. I conclude that my hypothesis was correct.

Summary Statement

I constructed an experimental setup and accurately measured the speed of a toy car with a buzzer mounted on top using the Doppler Effect.

Help Received

My father loaned me an oscilloscope and taught me how to use it. My father supervised and assisted me with the use of power tools during the construction of my experimental setup.