CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

35018

Project Title

F=-kv? The EM Parachute

Abstract

Objectives/Goals

To explore the parallel nature between eddy current and 'parachute' brake system, I performed experiment to show that magnetic braking force due to eddy current is proportional to the velocity of the falling magnet F=-kv in the conducting tube. The k constant and terminal velocity depend on the properties of the magnet and electrical resistance of the tube.

Methods/Materials

I derived a formula to compute the terminal velocity and the time for a magnet to fall through a conducting tube. My formula shows that the time is inversely proportional to the electrical resistance of the tube and also depends on the property of the magnet.

I performed experiments by dropping different magnets (neodymium disc vs. Plug) through conducting tubes of different electrical resistance (Copper: Cu vs. Aluminum: Al) but of same length and measuring the time it took to completely fall through each tube. Based on my formula, I can show that the ratio of fall time for a neodymium disc to fall through Cu tube and Al tube shall be the same as that of neodymium Plug. I can also show that the ratio of fall time for a neodymium disc and a neodymium Plug to fall through Cu tube shall be the same as that of Al tube. I call this time ratio method.

I also measured the time it took for a magnet to completely fall through two tubes by stacking one tube on top of another in alternate orders (Cu stack on top of Al vs. Al on top of Cu) . Based on formula, the time for a magnet to fall through Cu+Al is the same as that of Al+Cu tube. I call this time sum method.

Results

I used my experimental data to compute time ratio and time sum. Time ratio method shows that the time ratio is the same. Time time sum method shows that time sum is very close to the same.

Conclusions/Discussion

My hypothesis is correct that the force to brake a falling magnet in a conducting tube follows the F=-kv law. Both K and terminal velocity depend on properties of magnet and the resistance of the tube.

Throughout this experiment, I learned about the elegance of brake system that naturally adjust their braking force to suit the object speed. I hope to extend F=-kv to biology. I would like to design brake for light vehicles, such as skateboards that would engage upon detecting an increase in the rider's heart rate to prevent accidents and make sports safer.

Summary Statement

Verify that F=-kv is true for eddy current based EM braking system.

Help Received