CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)

Morgan A. McLeod

Project Number

22781

Project Title

The Physics of Skiing

Abstract

Objectives/Goals

This study was about finding a way to ski downhill faster.
Three major factors act to slow a skier- the slope of the run, the frictional force of skis against snow, and the aerodynamic drag.
These are described in "Equation of Motion" as follows:
A=g*sin(theta)-mu*g*cos(theta)-(Cd*Ap*rho*V^2)/(2*m).
Where: m=mass, A=acceleration, g=gravitational pull, theta=the degree of slope, mu=the dynamic friction coefficient (ski v. snow), Cd=the drag coefficient (air), Ap=frontal area (of skier), rho=air density, and V=velocity.
Analysis of this equation led to three possible independent variables to study; position or stance while skiing(wind resistance), weight of the skier(including equipment), and friction between skis and snow.
The factors effecting friction between skis and snow are complex, and therefore, the study was limited to changes in frontal area(Ap), and mass(m).
This led to the hyposthesis:
Decreases in skier frontal area and increases in skier weight should increase downhill speed.

Methods/Materials

Preliminary trials showed too much variability in successive ski runs(probably due to changing snow conditions) to obtain good control vs. variable data. Therefore, in the experimental trials, a control skier was run simultaneously with the variable skier. Skiers, using identical equipment and of the same weight, were timed on a straight, smooth course while skiing in either; an upright stance, a tucked position, or in an upright stance carrying a 10Kg. weight. Times were recorded for ten runs, and the data was analyzed and graphed.

Results

The data shows a 13% increase in skier speed over the upright control for a tucked run (tucked Ap=50% of upright Ap) but fails to demonstrate any significant change in speed with the additonal weight (weighted skier m=125% of non weighted skier m)).

Conclusions/Discussion

The data supported the Hypothesis for frontal area, but not for mass. Weighting may have increased the dynamic friction coeficient (mu) between the skis and snow, canceling out any benefit of increased mass at the speeds tested. Higher speeds may reveal the expected results for mass since "mu" is known to decrease with increasing velocity (V).

Summary Statement

Using physics to find a way to ski faster downhill.

Help Received

Mother and father helped with design of project, timing skiers, understanding formulas, and layout of display.

Preliminary