Staying Alive: The Physics, Mathematics, and Engineering of Safe Driving

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Introduction

For most teenagers, I suspect that mechanics is a fairly boring introduction to the field of physics. In my brief exposure to tutoring high school students and in perusing introductory physics books, it seems that most student problems and activities are very dull. It is hard to get excited about position, velocity, and acceleration, especially if they appear rather irrelevant to the average teenager's life. Mechanics, the first (and often dominant) topic that students study in a physics class, usually involves problems such as how long thrown balls stay up in the air or the trajectory of cannon balls. Most teenagers are interested in themselves, travelling, or cars: therefore, this module revolves around these subjects.

An introductory section emphasizes the importance of units, an important topic often ignored, as well as dimensional analysis. This topic is critical for understanding the topic of auto mechanics as well as other fields of science. This unit purposely uses units of feet as well as meters so that students gain experience in using and converting units.

The module is comprised of three projects. In the first project, students learn about position and movement by moving themselves and measuring their position and speed. After students master the basic concepts of position, distance, and speed, they will plan a trip using a map for their second project. Most students like to travel and mastering the concepts of position, time, speed, and velocity will provide them will allow them to plan trips, including how long it will take them to be driven to their sports practice at a new field, or where they should plan on spending the night during their next trip.

The third and major part of the module was written in an attempt to save lives. Too many teenage drivers get into crashes. I hope that by providing students with some realization of how quickly things can happen while they are driving that they might drive more prudently and defensively. According to an article in the 2/4/02 issue of Design News, "virtually all automakers around the world agree that the vast majority of accidents are caused by driver inattentiveness, and that a single second of warning could yield astonishing changes in the frequency and severity of collisions." In this section, students learn about braking distances, being drunk or talking on a cell phone while driving, the dangers of driving at night, passing on 2-lane roads, reaching for a CD while driving, and how much space to leave between cars on a freeway. Some fun applications of mechanics, such as the Doppler effect, gas mileage policy, and the expansion of the universe, are also covered.

This need to complete this unit was catalyzed, in part, by an editorial (Safe cars, great; safe drivers, better (5/1/00)) and a subsequent letter to the editor in Design News magazine. That letter to the editor by Steve Buchholz in the 7/3/00 issue stated "I was hoping to hear the voice of an engineer calling for programs to help those who take on the responsibility of controlling a vehicle and the safety of others to understand the physical laws under which they must operate, and programs to help people understand the limitations of their vehicles … and their driving skills." A similar sentiment is expressed by Leonard Evans in his excellent book, Traffic Safety and the Driver.

Note that I have not tried to reproduce the typical high school mechanics text nor have I attempted to derive standard mechanics equations. This unit will hopefully be useful to introduce, complement, or supplement existing instructional materials.

Most jobs require summarizing and presenting data in a meaningful manner, such as in tables, spreadsheets, and graphs. Therefore, many of these investigations involve

calculations for a wide range of parameters, with subsequent tabulating and plotting of the data.

This module is at an early stage of development, with much more yet to come. It is still incomplete in some areas.

I have tried to write this module so that it may be used at either the middle school or high school level. Please let me know whether or not I have succeeded. Constructive suggestions are always welcome - send me an email at Larry.Woolf@gat.com.

Dedication

This unit is dedicated to the memory of Chad Hama, age 19, who died in a tragic traffic crash during the development of this module.