# THE COMPLETE BOOK ON SPEED ENFORCEMENT

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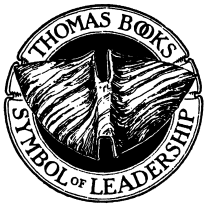
## A Practical Guide to Understanding Speed Enforcement Concepts and Devices

*By*

**KEVIN M. MORRISON**

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*In Memory of Sergeant Robert McLane Hall*
*(1949–2011)*

# PREFACE

Two intentions motivated the writing of this speed enforcement book: to give the reader a thorough understanding of speed enforcement concepts along with the devices that measure speed and, by means of many interesting applications, to prepare them to use these concepts and devices in their own professional careers.

I have heard many concepts about speed enforcement over the years and ultimately ended up becoming a speed enforcement instructor. During the time as an instructor, I kept on learning about both the methodology and the technology. I discovered that there was always one more thing my students wanted to know. I also discovered that in each class I taught, every student gained from a different part of the material. This book was written to give complete knowledge to the reader so that they can take from it something new each time they read it.

The book starts with a basis for the concept of speed in scientific terms. Speed is often the word associated with going "too fast." In reality, speed is simply a measure of motion. The book will explore some concepts of speed as they relate to energy and work. Understanding the physics of motion will help the reader to better grasp the realities of speed as it relates to its effect on safety. Also, both the positive and negative effects that various speeds have on the outcome of travel will be explored. Speed is useful to determining time expended and fuel usage and each of these have a correlated cost consideration. These concepts set a positive outcome at certain speeds and conversely they have a negative outcome when improper speeds are applied. Because of these negative effects, limits are established by communities and government. This book also addresses the methodology to determining a speed limit. The scientific process of establishing speed limits along with the emotional aspect of limiting speed is covered in terms the reader can relate to.

Fundamental to this book are the devices used to measure the amount of speed. From the basic concepts of time distance determination through instant speed detection devices such as speed radars and speed lasers, the reader will explore the historical developments, scientific principles, and operational considerations of these devices. These sections are presented with in-depth information using charts and illustrations to assist in a complete understanding. The reader will be given this information in easy to understand language in order to have a full grasp of both the scientific and operational differences of each technology along with the operative limitations associated with these technologies.

If you are using this book as a text for speed enforcement classes, you will find it to be comprehensive concerning all methods used to monitor and enforce speed laws. If your scope for the training you plan to provide is less than the subjects in this book, you may apply it in four tracks that are most popular:

- For Time Distance Applications, it is recommended that you use Chapters 1, 2, 3, 4, and 10.
- For Radar Applications, add Chapters 5 and 6 to the Time Distance concentration.
- For Laser Applications, add Chapters 7 and 8 to the Time Distance concentration.
- For Radar and Laser combined, the entire book is recommended.

The overall goal of an effective speed enforcement program is to instill a desire to obey the speed laws, therefore resulting in fewer citations issued as fewer violations occur. The desired outcome is to get the public to obey the speed laws because they believe in them. This book explores the concept of voluntary compliance and the associated methods of achieving such compliance.

The fact that many people do not immediately subscribe to speed laws as being needed, directs that those citations which are written must withstand court scrutiny. As such, the book will also review the elements needed for court acceptance of both speed law violations and the instruments used to measure those speeds. Actual case examples are used to emphasize the major legal points.

Speed enforcement has been a public concern for over 100 years. Devices to determine speed thereby assisting law enforcement in the detection of those exceeding speed limits, are constantly transitioning to meet current needs. Therefore this book ends with an examination of some devices on the horizon.

An important note for the reader: This book is written with quantities and units in both U.S. and metric measure so that the text can be read in either system independently of the other.

K.M.M.

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# Chapter 1

# PHYSICS OF MOTION

People have a built-in sense concerning motion. The body detects motion and the mind interprets it. When riding a roller coaster, people sense the movements of the car they are riding in, but they relate those movements to past experiences. As the roller coaster car climbs the initial length of track moving towards the main drop, there is anticipation. Then as the car drifts across the top, descends, and accelerates, the body feels the fall and the mind identifies the fact that in this situation you will need to stop at the end; preferably a controlled stop!

If we were to freeze time halfway down the fall, and then ask the riders what they think is about to happen, most will tell you that the car they are riding in will arc out of the fall and continue on to the next stretch of track. Some may be concerned that the speed they are falling and the weight in the car will cause them to derail. With a very rare exception, none of them could predict the potential danger they may face. They have the reassurance of past rides or having watched other roller coasters and observed that they ended without harm.

Maybe if I explained the physics behind the movement of the roller coaster, I could assure them and instill confidence. If they understood Newton's laws of motion, and were given the formulas to compute how the car will perform in their given circumstance, they would rest easy on the ride. Although this would be somewhat helpful, it would be impractical. For one thing, they don't want to be reassured. They took this ride for the thrill and they certainly don't want this ride to be mundane. But, it's important to know that those individuals who designed this ride have a working knowledge of the physics of motion.

In this chapter, you will be introduced to some concepts in physics as they relate to motion. They are presented here so that you can have reassurance and confidence that the facts in this book have a basis in science and math. Join this with the concepts of how things work and top it off with some experience to test the theories and concepts expressed here and you will end up with a high level of knowledge in speed enforcement.

## TIME AND DISTANCE IS SPEED

Almost everything in the world moves or has the potential to move. Probably the first studies in physics dealt with movement. This statement can be made since there is an extensive amount of study into this subject. Of the two individuals who stand out above others, Galileo Galilei (1564–1642) and Isaac Newton (1642–1727), it was the theories of Isaac Newton that resulted in a science discipline of its own, Newtonian Physics.

Speed is a measure of motion. Speed refers to how far an object moves in a given amount of time. How precise the measurement of speed is dependent on the amount of time and distance used for the calculation. Therefore, the general speed equation may be expressed as:

$$Average\ Speed = \frac{distance\ traveled}{time\ elapsed}$$

When this formula is used, the units of distance and time should be expressed in a conventional way. We usually speak of things as traveling a certain number of *miles per hour* or *mph* (*kilomters per hour* or *km/h*). The word *per* is represented by the divisor in the general speed equation and means in relation to some specific unit of measurement, in this case, a unit of time. For vehicle speeds, the measurement is often stated in units of one hour (i.e., miles per hour or kilometers per hour). If we are traveling on a long road trip and we started counting the distance markers on the side of the highway, the total markers we passed in one hour would give us a measure of our speed based on the standard distance the markers represented.

As you read this book, you may have noticed I used the term speed in relation to feet per second (meters per second). Those readers who may reconstruct traffic crashes learned that the term feet per second (meters per second) is a determination of velocity. The fact is that in everyday life, we use these terms interchangeably. In physics, the term velocity is used to signify magnitude of how fast an object is moving *and* its direction. For example, direction can mean acceleration (a positive direction) or deceleration (a negative direction). This would be common in crash reconstruction. Speed, on the other hand, is only magnitude.

In this book, both miles per hour (kilometers per hour) and feet per second (meters per second) are used to solve for speed, since we are only addressing uniform motion or quantifying motion. Velocity is used where laws of physics were discussed since they were originally stated that way.

Since we are going to express speed as miles per hour or kilometers per hour, it is important to understand that this time and distance formula is foundational to all speed calculation regardless of the methods used to determine the speed. In fact, each measurement taken to determine speed can be derived from the general speed equation. Let's look at a GPS unit that gives your speed as you are traveling. In one instant, the GPS has located you at a point on the earth. In the next instant, you are at a new point. Since latitutde and longitude positions are actual fixed locations, a change from one to another represents motion, or distance traveled. And with knowledge of the amount of time elapsed, this motion can be expressed as speed.

There is an inverse rule to the general speed formula. Since speed is a result of the relationship between the distance traveled and the time elapsed, then the following must be true:

1. The greater the distance and the shorter the time, then the higher the speed.
2. The greater the time and the shorter the distance, then the lower the speed.