TRAFFIC COLLISION INVESTIGATION INTERMEDIATE
Los Angeles Police Department Agency #1850
CNN: 33630 Revised 5/21/24

Instructional Goal: To provide students with the knowledge and skills necessary to effectively conduct traffic crash investigations through proper physical evidence identification and documentation. Then, based on the accurate documentation of physical evidence, estimate the minimum speed of vehicles involved in a crash

Performance Objectives: Using lecture and learning activities, the students will:

- Understand the definitions and terminology used in Traffic Crash Investigation and Reconstruction
- Properly and accurately identify and document different types of physical evidence
- Identify the basis for each numeric component of speed estimate equations
- Estimate the minimum speeds of vehicles based on physical evidence commonly encountered at the scene of traffic crash
- Complete time and distance analyses to determine position and sight line for drivers based on the speed estimates

I. COURSE INTRODUCTION AND OVERVIEW

A. Topic 1.0 - Introduction and Orientation
B. Brief overview of training goals and objectives
C. Required materials
D. Student responsibilities
E. Skill Assessment: Pre-course test
    1. Conduct a survey of the class to see the level of math experience each student has
    2. The first few hours of the course may be dry for those with strong math backgrounds, while stressing the importance of starting with the basics for those with strong backgrounds in other areas
F. Common Terminology
    1. ACCELERATION (a)
    2. CHORD (C)
    3. COEFFICIENT OF FRICTION or MU (f or μ)
    4. DISTANCE (d)
    5. ENDING VELOCITY (v_e)
    6. ENERGY (E)
    7. FORCE (F)
    8. GRADE (G)
    9. GRAVITY (g)
    10. HEIGHT (h)
    11. INITIAL VELOCITY (v_i)
    12. KINETIC ENERGY (KE)
    13. MASS (m)
    14. MID-ORDINATE (m)
    15. RADIUS (R)
    16. RESULTANT COEFFICIENT OF FRICTION or DRAG FACTOR (f_r)
    17. SPEED (S)
    18. TIME (t)
    19. VELOCITY (v)
    20. WEIGHT (w)

G. Reinforce key learning points
    1. In order to properly investigate and report traffic collisions, the investigator must have a clear understanding of the terminology that is accepted around the world in the traffic collision field
    2. Knowledge of the terminology ensures accurate, consistent documentation and reporting
    3. Knowledge of the basis for the variables used in the speed calculation equations enables an officer to use the equations in criminal cases and, if required, testify to them with confidence in court

II. TIRE MARKS & PHYSICAL EVIDENCE

A. Topic 2.0 - Introduction and Orientation
    1. Brief overview of goals and objectives
    2. Identify types of tire marks
    3. Identify the characteristics unique to each type of tire mark presented
    4. Identify the methods used to establish direction of travel from tire marks
    5. Recognize methods of tire mark photography under differing conditions such as daylight, nighttime, etc.
B. Importance of Tire Marks
C. Basic principles of physics
D. Tire mark definition and characteristics
    1. Impending: wheel rotating slower than the forward motion of the vehicle
    2. Locked wheel
    3. Four-wheel locked overlapping vs. four-wheel locked Independent
    4. Scrub marks
    5. Yaw marks
    6. ABS tire marks
    7. Skip skids
    8. Gap skids
    9. Acceleration marks
E. Other types of marks on the roadway
    1. Gouge marks
    2. Scrape marks
    3. Fabric transfer
    4. Human tissue transfer
    5. Vehicle fluids
F. Photographing tire marks
    1. During daylight hours
    2. Photographing during darkness
    3. Nighttime photographing procedure
    4. Other areas to photograph
    5. Other evidence

G. Court testimony

1. Once calculations have been completed and are used to establish a violation for which one is to be prosecuted, they may have to be explained to a jury
2. One of the main points of contention by the defense is usually the interpretation of the physical evidence (type of tire mark) and then its use to calculate the minimum speed of the vehicle

H. CLOSING: Reinforce key learning points

III. MATH REVIEW

A. Topic 3.0 - Introduction and Orientation
B. Algebra Review
   1. Equipment needed
   2. Overview the following ground rules
   3. Radical sign: $\sqrt{}$
   4. Exponents: x^2
C. Use of a calculator in this class
   1. Using and Understanding Calculators
   2. Four basic types of calculators
   3. Determining Your Calculator's Function
   4. Exponentiation and square roots
   4. Logarithms
   5. Trigonometric Functions
   6. Programmable
D. Determining Your Calculator's Functions
E. Basic Mathematical Principles
   1. Exponents
   2. Multiplication
   3. Division
   4. Addition
   5. Subtraction
   6. Square root
F. The Rules of Algebra
G. Solving an Equation for One Unknown
H. Multiplication and division are inverse operation
I. Negative numbers
J. The use of parentheses
K. Repeated Multiplying of a Factor. Base, Exponent and Power
L. Decimals and Fractions
M. Percent Conversions
N. CLOSING: Reinforce key learning points
   1. The basic Order of Operations must be used to use the equations you are going to learn in this class. If they are not used, the wrong answer will result
   2. Pay special attention to negative numbers as they play an important part in the resulting answer

3. Knowledge of algebraic equation manipulation techniques will help to rearrange equations to isolate the unknown

O. Assessment: Math Review and Quiz
1. Provide basic overview of what was covered during Topic 3.0 review
2. Handout Math Quiz Number 1
3. Grade and return quiz

IV. EVIDENCE DOCUMENTATION

A. Topic 4.0 - Introduction and Orientation

B. Brief overview of goals and objectives

C. Methods of Measuring and Documenting Physical Evidence.

1. Pacing
2. Rollermeter
3. Tape measures

D. The four steps of preservation of non-recoverable physical evidence: Identify, measure, record and photograph
1. Identify the evidence
2. Measure the evidence
3. Record the measurements
4. Photograph the evidence

V. SKID DOCUMENTATION FIELD PROBLEM

A. Brief overview of goals and objectives
1. Review field deployment procedures
2. Students will respond to the intersection where the instructor has previously laid down tire marks on the roadway
3. The field project is worth 20 points toward the final grade
4. Students will measure intersection, and basic field sketch
5. In the classroom the students will diagram intersection. Describe evidence, determine type of tire mark and direction of travel.
6. Using the proper tools and methods of documentation helps produce consistency and confidence in reporting and court testimony

B. Reinforce key learning points. ASSESSMENT
1. Properly identifying and documenting the various types of physical evidence encountered at the scene of a traffic collision is necessary to complete a speed analysis
2. Photography is an integral part of evidence documentation that cannot be overlooked

VII. DRAG FACTOR AND GRADE

A. Topic 5.0 - Introduction and Orientation. Definitions:
1. ACCELERATION (a)
2. GRAVITY (g)
3. BRAKING EFFICIENCY (B_e)

4. COEFFICIENT OF FRICTION or MU (f or μ)
5. GRADE (G)
6. DRAG FACTOR or RESULTANT COEFFICIENT OF FRICTION (f_r)
7. SPEED (S)
8. VELOCITY (v)

B. Three Methods of Determining the Coefficient of Friction on a given roadway
    1. The most accurate method is to conduct test skids
    2. Procedure for conducting test skids
    3. Another method that can be used is a drag sled
    4. The final method to determine the coefficient of friction of a roadway is to use published tables

C. Factors effecting the coefficient of friction
    1. Roadway surface: Asphalt, concrete, dirt, gravel, etc.
    2. Tires
    3. Grade
    4. Weather
    5. Other factors that are present, but that are so minute that we do not account for them

D. How braking efficiency can affect the stopping ability of a vehicle
E. Other considerations
D. **ASSESSMENT:** Determining Roadway Grade: Have the students describe in detail the methods and tools that can be used to determine the roadway grade

VIII. SPEED COMPUTATION

A. Topic 6.0 - Introduction and Orientation
B. Speed Calculation from Physical Evidence
    1. Refer to the Equation Sheet located in the front of the Student Manual
    2. The equation sheet is divided into three sections
    3. This equation sheet can be used during the class and for all tests. Although you will get to know some of the equations by heart, we do not expect you to memorize them
    4. Converting Speed to Velocity (Miles Per Hour to Feet Per Second)
    5. Converting Velocity to Speed (Feet Per Second to Miles Per Hour)
    6. Minimum Initial Velocity (v_i) on a single surface
C. **ASSESSMENT:** Initial Velocity on a Single Surface. Exercises 1-6
D. **ASSESSMENT:** Minimum Velocity over Multiple Surfaces. Exercises 7-17
F. Time and Distance Analyses
G. Time and Distance Calculations
    4. **ASSESSMENT:** Hand out scenarios 18 - 28, one at a time
    5. Scenario 18: Velocity of vehicle is 80 feet per second. Calculate distance traveled during a perception time of .75 of a second. This is done individually by each student at their desk.
    6. Scenario 19: Vehicle velocity 65 feet per second. Calculate distance traveled during a perception time of .75 of a second.
    7. Scenario 20: Vehicle velocity 80 feet per second. Calculate distance traveled during a perception time of .75 of a second.
    8. Scenario 21: Vehicle velocity of 80 feet per second. Calculate distance traveled during perception and reaction time.

9. Scenario 22: Vehicle traveling 45 Miles per hour. Calculate distance traveled during perception and reaction time.
10. Scenario 23: Vehicle slides to a stop. Roadway coefficient of friction of .70 over 180 feet. Calculate distance traveled during driver's reaction time.
11. Scenario 24: Vehicle slides to a stop. Roadway coefficient of friction of .55 over 105 feet. Calculate vehicle's total stopping distances.
12. Scenario 25: Vehicle slides to a stop over two surfaces leaving 4 wheel locked independent dent tier marks. First surface slide is 105 feet with friction coefficient of .75, then slides to a stop over a second surface for 45 feet with a coefficient of friction of .55 and a2% down grade. Calculate stopping distance.
13. Scenario 26: Vehicle slides to a stop on a roadway with a coefficient friction of .70 over 150 feet. Calculate time to skid 150 feet.
14. Scenario 27: Vehicle slides to a stop on a road with a coefficient of friction which is .70 over 60 feet. Calculate time to skid 60 feet.
15. Scenario 28: Vehicle slides to a stop on loose gravel with a coefficient of >40. It takes 560 feet to stop. Calculate total stopping time in seconds.
16. Complete each scenario on the white board while the PowerPoint presentation is running

H. Reinforce the key learning points

IX. SKID TESTING & DRAG SLED FIELD PROJECT

A. **SPEED COMPUTATION FIELD PROJECTS**
B. Drag Sled and Skid Marking
C. Skid Measuring
    1. Documenting the type of tire marks and justifying their conclusion with the characteristics of those tire marks
    2. Documenting the direction of travel of the vehicle and justifying their conclusion with physical evidence
    3. Calculating a minimum speed for the vehicle
D. Reinforce the key learning points

Day 5

X. CASE STUDIES

A. Brief overview of training goals and objectives
B. Case Studies
    1. **ASSESSMENT:** Case Study A-F
    2. Case Study A: Test skids in the intersection.
    3. Case Study B: Determine Speed and acceleration rates of vehicle at the beginning of the skids, and on various surfaces.
    4. Case Study C: Calculate minimum speed at beginning of yaw marks. Calculate acceleration rate range, and minimum velocities.
    5. Case Study D: Calculate minimum speed of a vehicle involved in a collision from three weeks ago.
    6. Case Study E. Calculate the speed of vehicles involved in fatal DUI Traffic.
    7. Case Study F. Determine who ran a red light. Calculate the speed of a vehicle at beginning of a skid. Convert 5mph impact speed to feet per second.

C. CLOSING: Reinforce key learning points

XI. COURSE REVIEW AND FINAL EXAM

A. Course Review

B. **Assessment:** Final Exam. Test knowledge on proper skid mark documentation and analysis.