

# Automobile-Accident Reconstruction

Noble High School

Fall, 2003

## Lesson Information

- **Grade Level**  
11-12
- **Subject areas**  
Trigonometry
- **Duration**  
3-4 one-hour class periods
- **Setting**  
A trigonometry class, preferably with students who are taking or who have taken physics. An outdoor space where two cars can be positioned, preferably in an intersection setting, and where spray painting or chalking of the road surface would be permissible.
- **Vocabulary**  
Momentum  
Velocity  
Coefficient of friction  
Vector  
Force  
Acceleration  
Drag tire  
Scale drawing
- **Materials**  
Two cars  
Drag tire (1)  
Hanging scale (1)  
Spray paint or sidewalk chalk  
Tape measure (50')  
Scientific calculators (one for each group)  
Graph/draft paper (several sheets per group)  
Yardsticks (one per group)  
String (50 feet)  
Posterboards (one for each group)  
Scissors (one for each group)  
Markers (several)  
Glue/tape
- **Additional Resources**  
Caples, L. G. (1992). Squeal those tires! Automobile-accident reconstruction. *Mathematics Teacher*, 85, 56-61.  
<http://www.accidentreconstruction.com/>  
<http://www.dps.state.ok.us/ohso/>  
(Oklahoma Highway Patrol facts)

## Summary

Students use trigonometry, vectors, and conservation of momentum from physics to investigate a mock accident scene. They determine the speed the cars were going before applying the brakes and the speed at which the cars collided, in order to find out if the cars were speeding.



## Objectives

Students will:

- Demonstrate teamwork skills
- Produce an accurate scale drawing from distance and angle measurements
- Apply the formulas for the coefficient of friction, obtaining speed from skid marks, conservation of linear momentum, and the combined speed formula to calculate the speed prior to an auto collision
- Construct an accurate vector diagram
- Create a poster presentation of the problem data and solution

## Oklahoma Priority Academic Student Skills Objectives

No PASS skills exist for trigonometry. The following PASS skills apply to aspects of this task.

Geometry Content Standards:

IID. Use geometric tools (e.g., protractor, compass, straight edge) to construct a variety of figures.

II E. Find angle measures and arc measures related to circles.

Algebra II Content Standards:

IA. Define and perform operations on real and complex numbers.

## Background Knowledge

The instructor should be familiar with:

- How to produce an accurate scale drawing from distance and angle measurements
- Applying the formulas for the coefficient of friction, obtaining speed from skid marks, conservation of linear momentum, and the combined speed formula to calculate the speed prior to an auto collision
- Constructing an accurate vector diagram
- Visually displaying problem data and solution

The students would need the following entry skills:

- Graphing linear functions
- Ability to use and create map scales
- Ability to choose and input appropriate information into the unknowns of a formula and solve algebraically or with trigonometry (such as sines and cosines)
- Knowledge of the concept of vectors—that a vector represents direction and magnitude of some quantity
- Ability to use a tape measure

# Procedures

## Enlisting help from law enforcement

Contact your local police department or highway patrol to ask for a speaker and assistance with the activity. Arrange dates and times (approx. 20 minute presentation). Also ask to borrow a drag tire for the activity (if the local police do not have a drag tire, check with the highway patrol or an insurance company).

## Day 1

The law enforcement officer should speak first. Ask the officer to speak about road safety in different condition, defensive driving, and how they investigate accidents. Then preview the activity for the students and teach them how to use a drag tire correctly. Depending on prior knowledge, review the concept of vectors. Have students form their groups.

## Preparation for Day 2: Preparing the accident scene

Identify the location for the accident reconstruction. Ideally this would be a location where roads or driveways intersect and where spray painting or chalking some lines on the surface would be permissible. If an intersection is not available (for example if you have a parking lot available) you should create one with sidewalk chalk, spray paint, tape, etc. Mark off the curbs of the intersection, leaving at least a width of one lane between the curbs.

Position the cars at a 90° angle so that they are almost touching (see if the police will help by allowing you to use their squad cars). Mark the location of all the tires while the cars are in this position, preferably with tape or chalk so that paint will not get onto the tires.



Use spray paint or sidewalk chalk to simulate skid marks behind the tires of each vehicle. The suggested range for the length of the skid marks is 35-45 feet. Also draw x and y axes on the road, through the center of the two cars. Reposition the cars as if they had veered off after the collision. See diagram on completed lesson link.

Find out the weights of the two models of cars. If unknown, car weights for new cars can be found at [www.edmunds.com](http://www.edmunds.com) by clicking on Reviews, finding the make and model, and then clicking Specifications in the review. The weights of older vehicles can be approximated by looking at new vehicle weights. You can also get weights from [www.caranddriver.com](http://www.caranddriver.com) by looking under Buyer's Guide for Reviews and Road Tests, and selecting the make and model.

## Day 2

Give out and go over their project handouts.

Assist student groups as they measure the accident scene and as they perform the measurements with the drag tire. Provide assistance for the scale drawing. (See student handouts for the information that the students will need.)

## Day 3

Assist students as they perform calculations, finish scale drawing, produce the vector diagram, and start their posters.

## Day 4

Finish and put up the posters for group presentations.

# Technology Component

The lesson as currently designed makes use of scientific calculators to find magnitude and angles, and a hanging scale to determine the coefficient of friction.

Law enforcement officers and accident reconstructionists use software with handheld units, PocketPC's, laptops, or desktop computers to more easily measure and diagram accident scenes. Although this software is relatively expensive to buy, using it would enable students to attempt accident reconstruction with the tools used by law enforcement. Details are at <http://www.accidentreconstruction.com/newsletter/jul03/cad.asp> and <http://www.cadzone.com/>



## Assessment

- The product to be assessed is a poster containing the scale drawing and the problem data and solution.

## Possible Extensions

- This activity could be related to the physics curriculum in the areas of momentum, ballistics, and normal and tangential acceleration. In addition, a more advanced class (whose students have taken physics) could derive the equations for obtaining speed from skid marks and for combined speeds. Classes could also use trigonometry to determine the angles of the cars at rest, rather than using protractors.
- Students could also give a safety presentation to school groups or driver's education courses, discussing their findings and their implications for safe driving.

