BULLET TRAJECTORY

Objective:

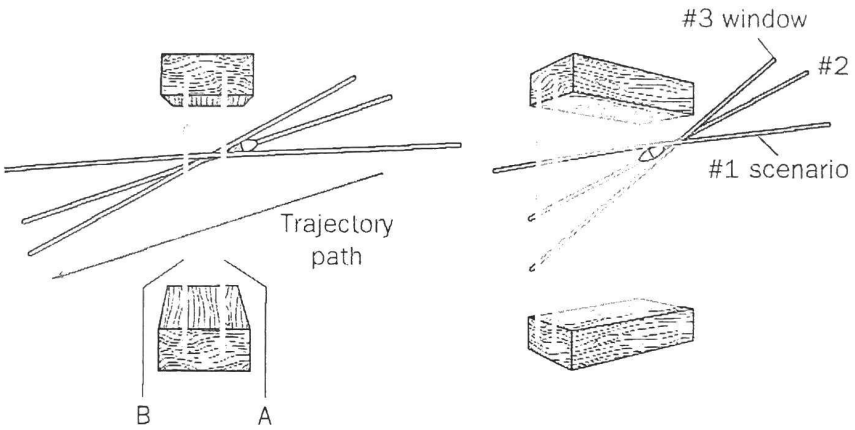
By the end of this activity, you will be able to:

1. Analyze three different crime scenes.
2. Determine information about the shooter's position.

Time Required to Complete Activity: 40 minutes (teams of two students)

Introduction:

The device pictured below is a model representing three different bullet trajectories that will be used in the three scenarios in this activity.



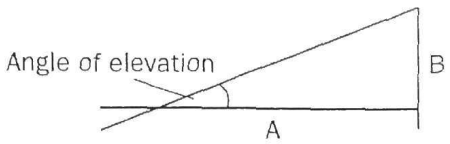
The angle of impact (the bullet's path) is the angle created by the pathway of the bullet and the horizon. To determine this angle, at least two points along the trajectory path must be identified. These two points could be an entry wound (A) and exit wound (B) or possibly a windshield penetration (A) before entering the body (B). By identifying the location of the shooter, we may be able to collect additional evidence to help identify the firearm.

Recall the Law of Tangents. This law states that:

Tan of an angle of elevation = $\frac{\text{Opposite side (B)}}{\text{Adjacent side (A)}}$

If the distance from the wound to side A can be measured, side B can be calculated.

If the angle of elevation and side A can be measured, then it is possible to calculate side B.



Materials:

ruler

calculators with sine function or tangent table

Safety Precautions:

None

Scenario 1:

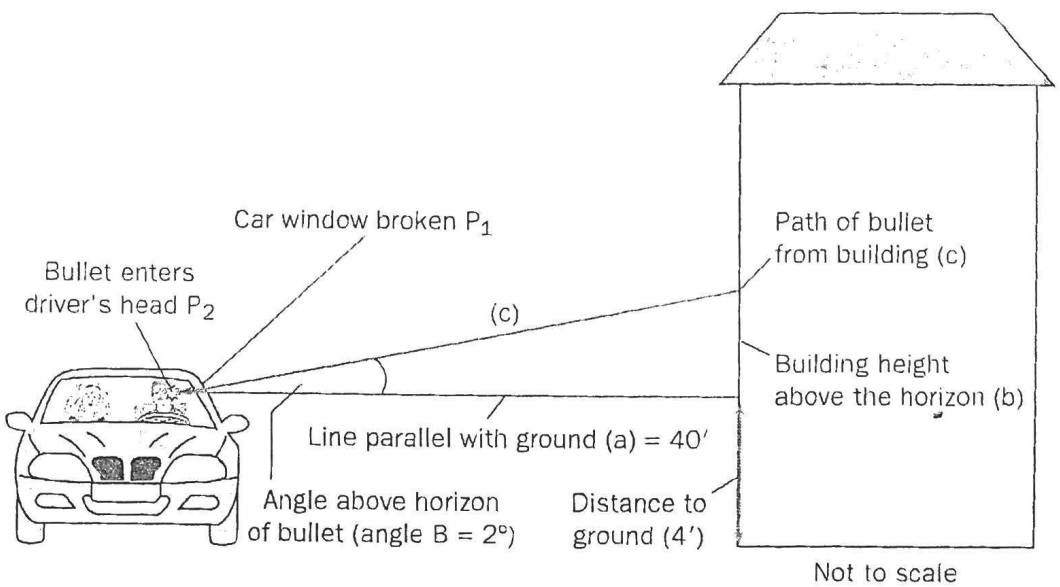
A victim was shot from a bullet that came through his front car window as shown in figure below. Witnesses saw a muzzle flash from a nearby building, but were unsure from which floor the flash originated. The path of trajectory can be determined by using Point 1 (P_1), the broken windshield, and Point 2 (P_2), the point where the bullet entered the victim's head.

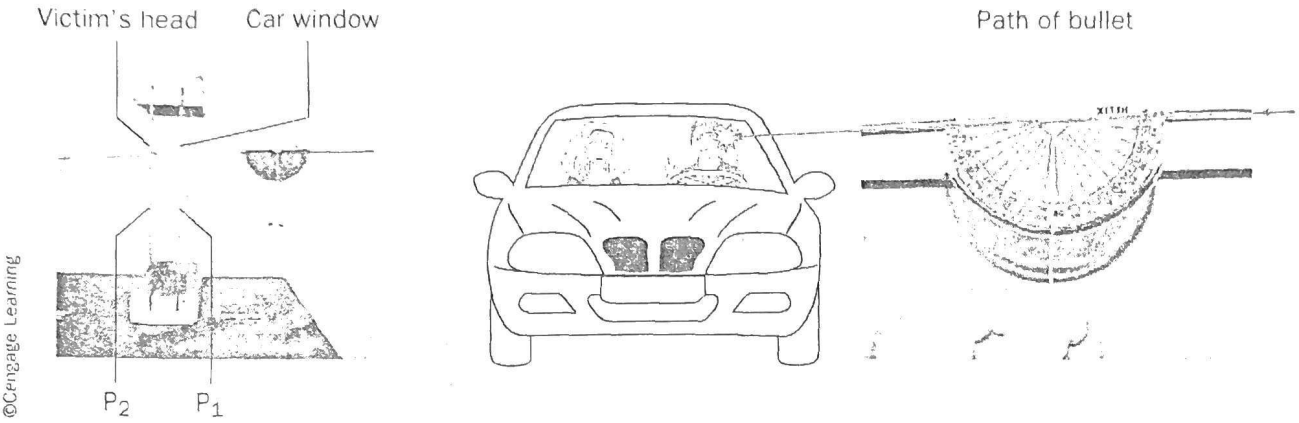
Procedure: Part A

1. According to the sketch the angle of trajectory is 2 degrees.
2. The distance to the building in question is 40 feet.
3. Calculate the height of the shooter using the Law of Tangents.

Height of gun = Height above horizon + distance to ground

The window (P_1) and the point of head penetration (P_2) provide two points used to determine the angle of the shooter's position above the driver's location.





Using a Trajectory Model to Simulate the Crime Scene

To simulate the crime, this method uses a protractor, some thread or dental floss, and a washer or some other weight. The path was right to left. The angle appears to be about 2 degrees from 90. This translates to 2 degrees above the horizon (upward to the right). The bullet therefore moved in a downward direction about 2 degrees from the gun through the window to the victim from right to left and downward.

A second method of determining the height of the shooter uses a laser pointer as pictured on the right. A laser pointer can be projected toward the location of the shooter and may assist in determining the shooter's position. Neither method is perfectly accurate, but both will give a fair approximation.

Calculation Position Using the Law of Tangents

Distance to building $\approx$ 40 feet

angle of elevation (–) = 2

Solving using the Law of Tangents:

Tan of angle of elevation = opposite/adjacent

Tan – = opposite side/adjacent side

$$\text{Tan of } 2^\circ = \frac{b \text{ (height of building above wound or above the horizon)}}{a \text{ Distance to the building (40 ft)}}$$

$$.035 = \frac{x}{40 \text{ ft}}$$

x = 1.34 ft above the head wound

Total height of shooter = height above the head wound + distance from head wound to ground

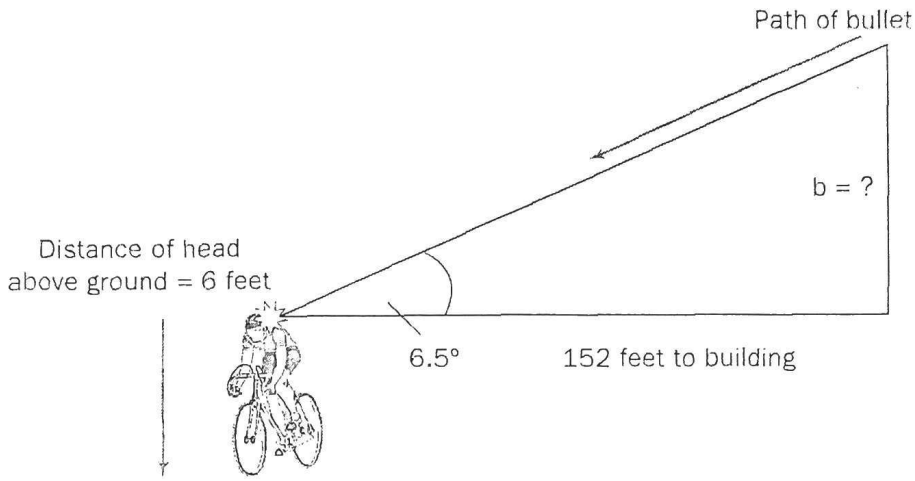
Shooter height = 1.34 ft + 4 ft = 5.34 ft

The shooter was located on the first floor.

Scenario 2:

Refer to the figure at the beginning of the activity.

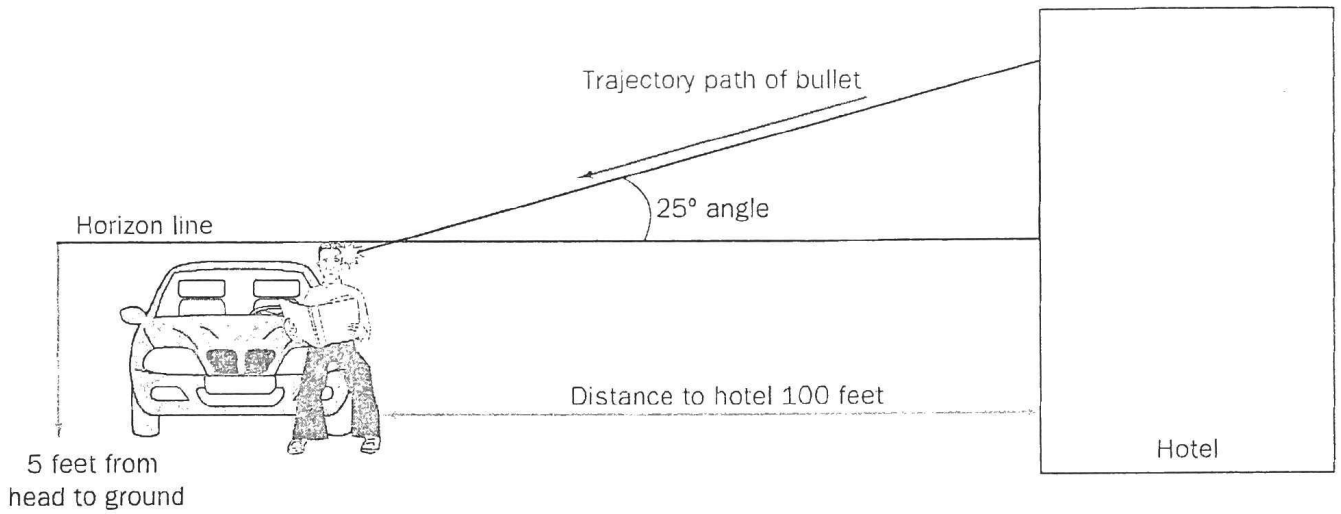
Witnesses saw a victim fall while riding his bike. He had been struck in the head by a bullet. When the crime-scene investigators arrived, they calculated the angle of elevation of the shooter to be about 6.5 degrees. The distance to the building from which the bullet was fired was 152 feet, and the height of the entry wound on the victim while on his bike measured 6 feet above the ground.



Solve for height using the tangent method. Show your work.
Height = _____feet

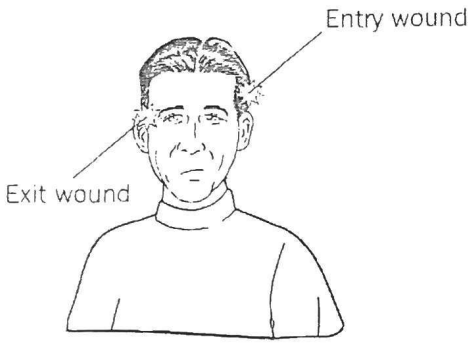
Scenario 3:

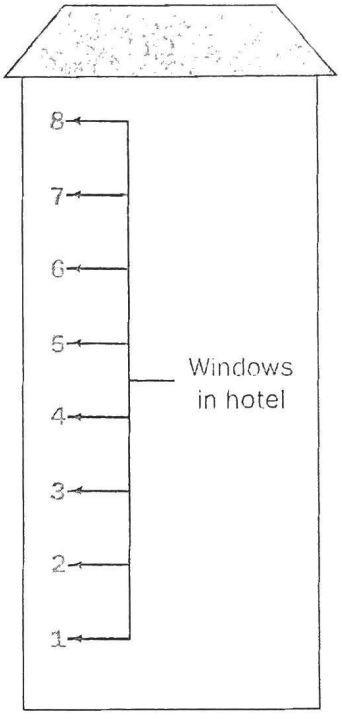
Part A:
A man is shot from a hotel window while sitting on the hood of his car. Use the following information to determine from which window the shot came. The trajectory angle is 25 degrees.



At what distance above the ground was the shot fired? Show your work. This will help locate the correct floor.

Part B:
Using the diagram at the top of the next page, determine the correct window.





The bullet was fired from which window?
Draw lines illustrating how you arrived at your conclusion.

Final Analysis:

1. List problems that might interfere with the accuracy of your results.
   a.
   b.
   c.

2. What problems would be encountered if we couldn't accurately determine the trajectory angle?
   a.
   b.

Solve the following:

3. Angle of entry (trajectory) = 15° and the distance to the building is 700 feet
   Height of shooter ~_____ feet (above the horizon since the person could be sitting or standing and not be at ground level)
4. Angle of entry (trajectory) = 27° and the distance to the building is 60 feet
   Height of shooter ~_____ feet above the horizon
5. Angle of entry (trajectory) = 35° and the distance to the building is 85 feet
   Height of shooter ~_____ feet above the horizon