

TRAINING LAB - FIREARMS AND BALLISTICS: USING BULLET TRAJECTORY TO DETERMINE THE POSITION OF A DISTANT SHOOTER

NAME _____

Background: You have been trained to locate the position of a close range shooter by using bullet holes and stringing the crime scene. The shooter was located where the bullet trajectory paths (the strings) intersect – the Point of Origin. But what if the shooter was a long distance away when they fired their weapon at the crime scene – let's say a football field away. It's not practical, or very accurate, to run strings across such a long distance to find the position of a shooter. We'll have to find a more accurate method to locate a distant shooter's position, and that's what this Training Lab is all about

1. You will be trained to determine the position of a shooter when bullets were fired from a distance.

Procedures:

1. Sometimes stringing a crime scene to determine a bullet's trajectory (and the shooter's location) isn't practical – especially when the shooter fired bullets from a long distance away. It's often easier to make a detailed sketch showing the crime scene, bullet holes, and surrounding area. Next, draw long, straight lines through the bullet holes on the sketch to illustrate the bullet's trajectory over long distances. Of course, this method is only accurate if all measurements and sketches are accurate.
2. Below is the Police Report for a crime that just happened – please read the report.

OFFICIAL POLICE REPORT

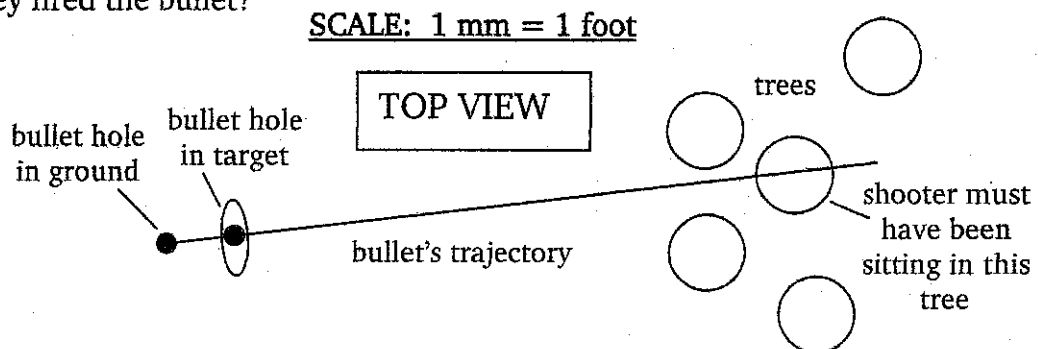
At 9:30 P.M. yesterday evening Mr. Jackson, 1688 West Trajectory Lane, was in his kitchen when he heard what sounded like gunshots. He ran to the living room and discovered a bullet hole in his window. Mr. Jackson immediately called the police. Police discovered Mr. Jackson's house had been hit by THREE bullets (one in the dining room and two in the living room), which left behind six bullet holes. Police carefully measured and recorded the locations of the six bullet holes.

Mr. Jackson has apparently been fighting with his neighbors for years. The police have been called out on many occasions to break up arguments and fights between Mr. Jackson and the Nixon family, Pyle family, and White family – all who live across the street from Mr. Jackson. It is believed that one of these families (Nixon, Pyle, or White) fired the bullets into Mr. Jackson's home.

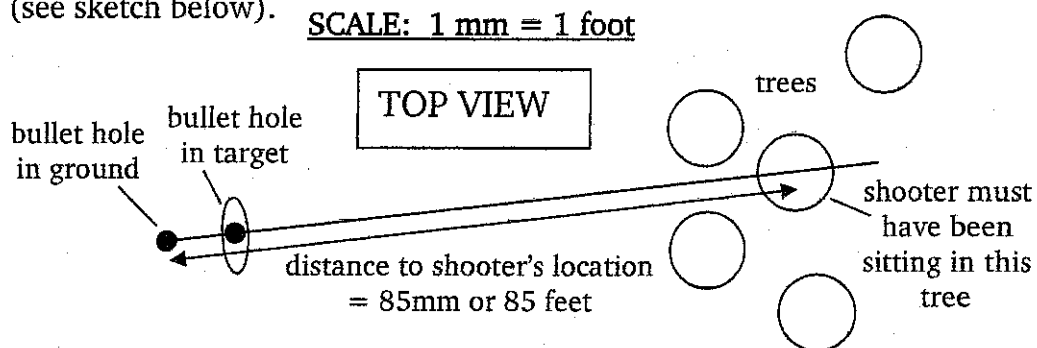
3. Table 1 contains the bullet hole measurements collected by the police.
4. Figure 1 contains a detailed TOP VIEW sketch of Mr. Jackson's house and the neighborhood. As the crime scene investigator in this case you will need to:
 - A. Place the bullet holes in their correct locations on the TOP VIEW sketch. Use the information found in Table 1 to complete this task. The Scale is 1 mm = 1 foot.
 - B. Determine each bullet's trajectory (use a pencil and ACCURATELY draw straight lines through the bullet holes to find their trajectories).
 - C. Determine the location of the shooter. The shooter's location will be where two or more bullet trajectories seem to intersect (try adjusting the lines slightly if they don't intersect perfectly). Place a "Dot" at the shooter's likely location. Finding a shooter's location is usually more difficult if you are working with only a single bullet trajectory.

Complete these tasks now, then return to step #5 below when you have finished.

5. As you can see, detailed sketches can help you find the position of a shooter that fired their weapon from a distance. However, you have not really found the EXACT location of the shooter in this crime (the Point of Origin)! The houses in this neighborhood are several floors or levels high. What floor was the shooter located on when they fired their weapon (what was their elevation or height)?
6. It would be easy to determine the shooter's height if you were "stringing" the crime scene – simply measure the height of where the strings intersect (the Point of Origin). For bullets fired from a distance, however, we must use another method to determine the shooter's height, and it involves our good friends the Right Triangle and Trigonometry.
7. EXAMPLE: Imagine there was a person sitting up in a tree and they fired a single bullet at a target on the ground, which left behind two bullet holes (see the sketch below). By using a TOP VIEW sketch and drawing in the bullet's trajectory you can determine which tree the shooter was sitting in. But how high up in the tree was the shooter located when they fired the bullet?



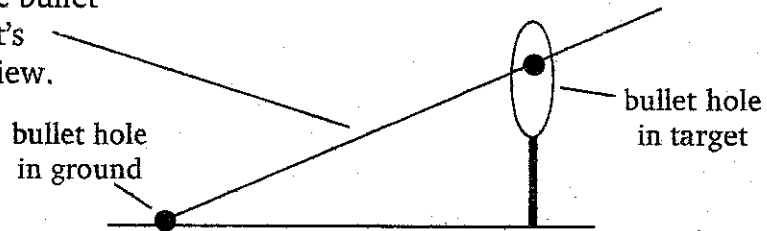
Step #1 – Measure the distance from the furthest bullet hole to the shooter's location (see sketch below).



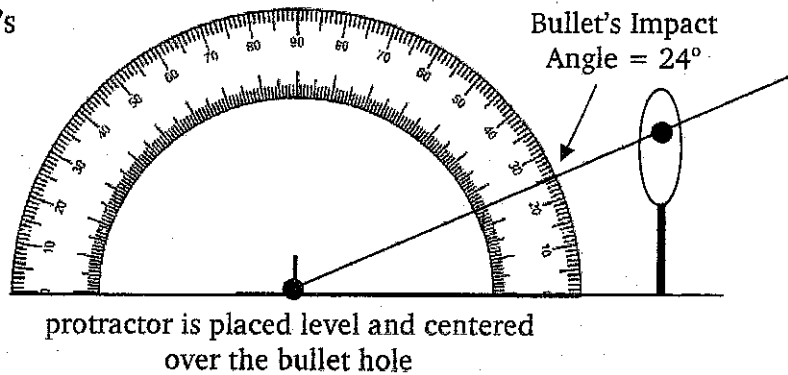
Step #2 – Determine the Bullet’s IMPACT ANGLE. This can easily be determined by looking at a SIDE VIEW of the bullet’s trajectory and using a protractor to find the angle (see sketch below).

SIDE VIEW – enlarged

A. Draw a line through the bullet holes to show the bullet’s trajectory from a side view.



B. Use a protractor to find the Bullet’s Impact Angle.



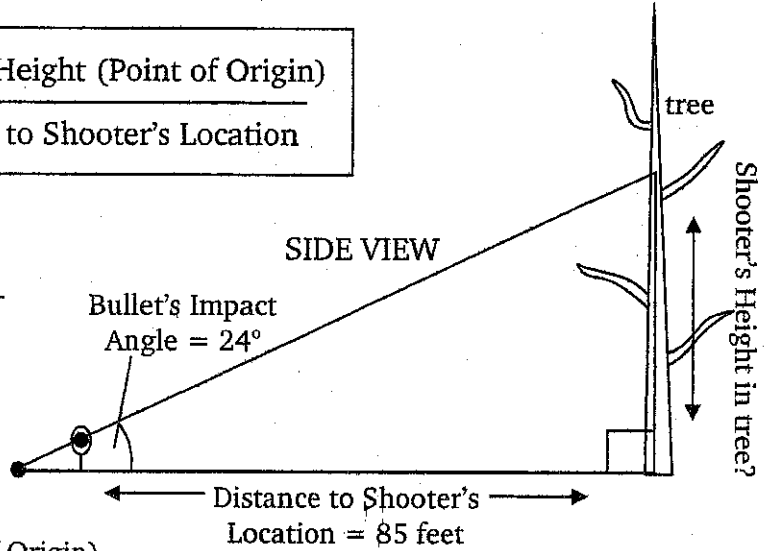
Step #3 – A right triangle is defined in this problem (see sketch below). To determine the Shooter’s Height (Point of Origin) use the simple Trigonometry formula below. You will need a scientific calculator OR trigonometry table to complete the “Tangent of Bullet’s Impact Angle” calculation.

$$\text{Tangent of Bullet's Impact Angle} = \frac{\text{Shooter's Height (Point of Origin)}}{\text{Distance to Shooter's Location}}$$

$$\text{Tangent of } 24^\circ = \frac{\text{Shooter's Height (Point of Origin)}}{85 \text{ feet}}$$

$$0.445 = \frac{\text{Shooter's Height (Point of Origin)}}{85 \text{ feet}}$$

$$38 \text{ feet} = \text{Shooter's Height (Point of Origin)}$$

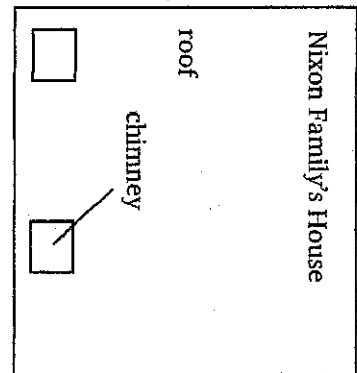
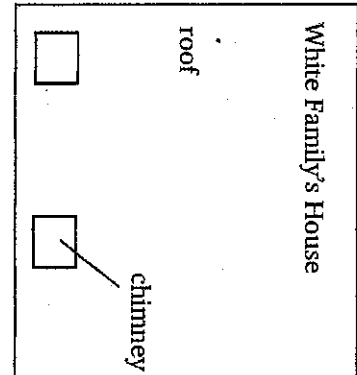
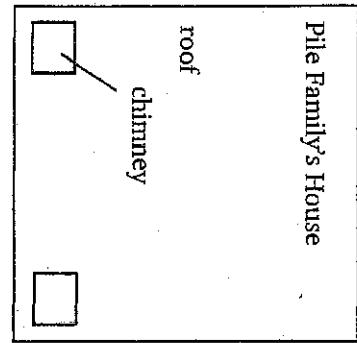


The shooter was located 38 feet up in the tree when the shot was fired!

8. Measure the "Distance to Shooter's Location" for each of the three bullets that were fired into Mr. Jackson's house (using the bullet trajectories and bullet holes found in Figure 1 sketch). Record your measurements in Table 2 (found below).
9. Use the Enlarged SIDE VIEW of the bullet holes (found in Figure 2) and a small protractor to determine the "Bullet's Impact Angle" for each bullet. Record the Impact Angles in Table 2.
10. Use the "Distance to Shooter's Location" and "Bullet Impact Angle" to calculate the "Shooter's Height" for each of the fired bullets and record in Table 2.
11. Calculate the "Average Shooter's Height" based on the fired bullets and record in Table 2.
12. Figure 2 contains a FRONT VIEW of the neighbor's houses (as viewed from Mr. Jackson's house). The Scale is 1 mm = 1 foot. This front view allows you to determine the heights of the floors/levels in each house. Use the Bullet Trajectory and Shooter Height information you have collected to determine the EXACT location of the shooter (Point of Origin) in Figure 2. Place a "Dot" on Figure 2 to show the shooter's EXACT location.
13. Draw trajectory lines from the shooter's location in Figure 2 to illustrate how the bullets traveled from the gun and penetrated the windows in Mr. Jackson's front wall.
14. A shooter's location at a real crime scene could be determined in the same way you found the shooter's location in this simulated Training Lab. Bullet holes would be used to determine trajectories, tape measures or other measuring devices would be used to determine distances to other buildings, and a protractor would be used to determine Bullet Impact Angles.
15. Answer the Training Lab Questions.

Table 2 – Measurements and calculations completed to determine the exact location of the shooter

	Distance To Shooter's Location (in feet)	Bullet's Impact Angle	Shooter's Height (in feet)	Average Shooter's Height (in feet)
Bullet #1				
Bullet #2				
Bullet #3				



West Trajectory Lane

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FIGURE 1 – TOP VIEW of Mr. Jackson's house and neighborhood

TOP VIEW

SCALE: 1 mm = 1 Foot

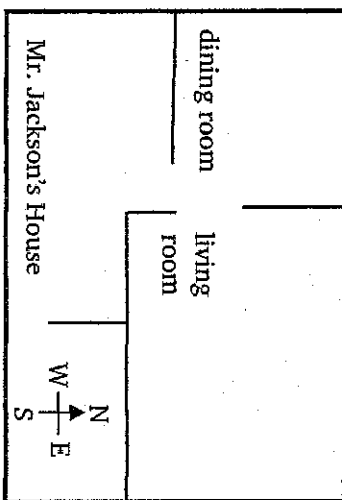


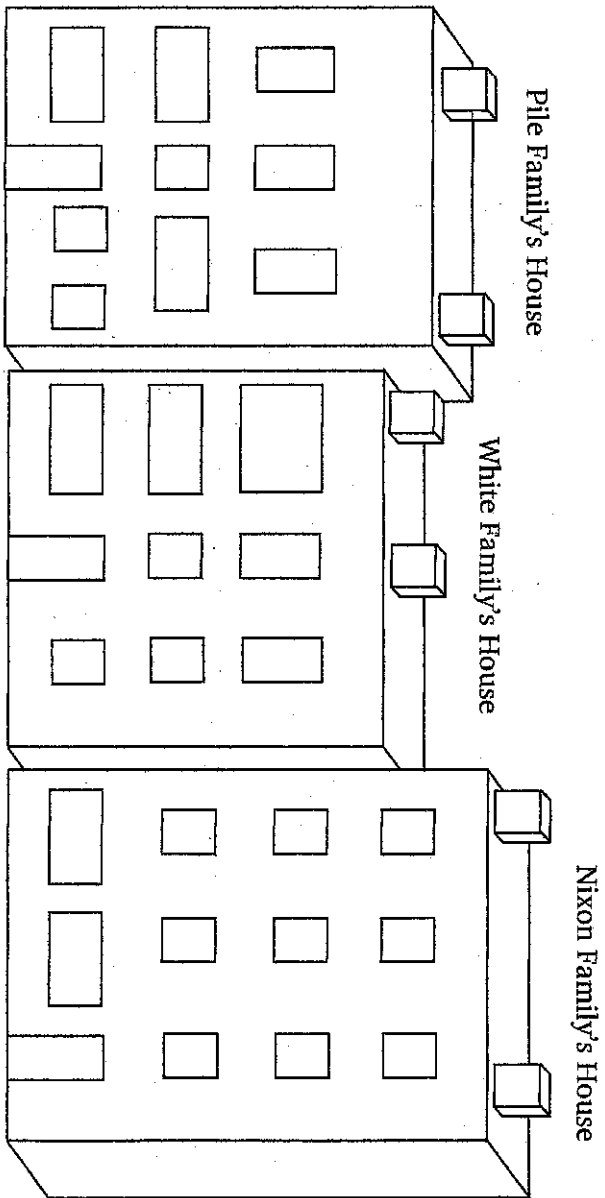
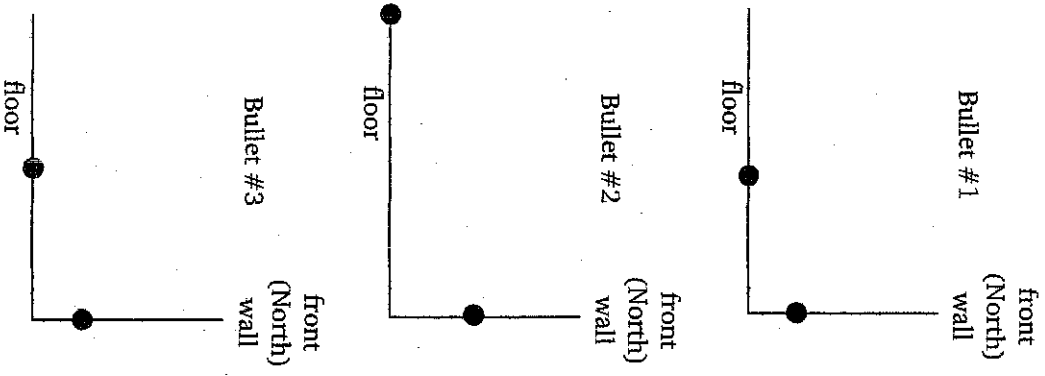
Table 1 – Bullet Hole Measurements collected from Mr. Jackson's House

	Bullet #1		Bullet #2		Bullet #3	
	Hole #1	Hole #2	Hole #1	Hole #2	Hole #1	Hole #2
General Location	through the North wall of Dining Room	on the Dining Room floor	through the North wall of Living Room	on the Living Room floor	through the North wall of Living Room	on the Living Room floor
Distance From West Wall (in feet)	9 feet	11 feet	32 feet	45 feet	45 feet	52 feet
Distance From North Wall (in feet)	0 feet (on the wall)	11 feet	0 feet (on the wall)	28 feet	0 feet (on the wall)	10 feet

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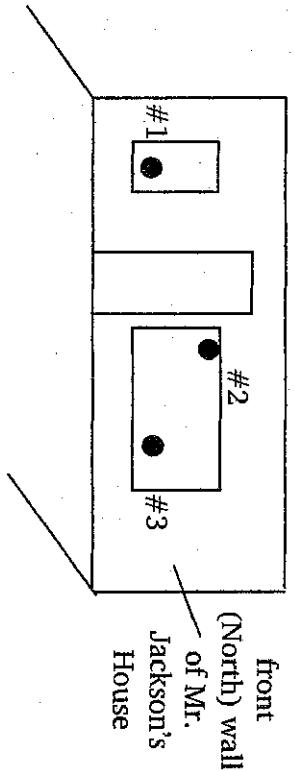
FIGURE 2 - FRONT VIEW of Mr. Jackson's neighborhood

SIDE VIEW -
enlarged
to determine Bullet
Impact Angles



FRONT VIEW

SCALE: 1 mm = 1 Foot



**QUESTIONS - FIREARMS AND BALLISTICS: USING BULLET TRAJECTORY
TO DETERMINE THE POSITION OF A DISTANT SHOOTER**

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Use your analysis of the Mr. Jackson house shooting to answer Questions #1 - #6.

1. In which house was the shooter located? _____
2. At what average height (in feet) was the shooter located when they fired their weapon?

3. What floor/level was the shooter located on when they fired their weapon? _____
4. What window was the shooter standing in when they fired their weapon?
5. About how far back (in feet) from the window opening was the shooter when they fired their weapon?

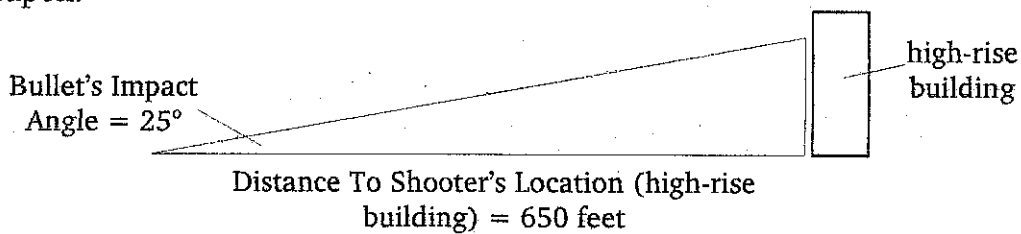
6. Look back at your answer for Question #1. Was a person living in this house guilty of shooting at Mr. Jackson's house? Explain your answer.

7. What is some other evidence you would look for that might help you identify the shooter in this case?

Description Of Evidence	Where Would You Look For This Evidence?	How Would This Evidence Help You?

8. In this Training Lab you learned how to determine a bullet's Impact Angle by using TWO bullet holes. You drew a trajectory line through the two bullet holes and measured the Impact Angle. You enter a new crime scene and discover a SINGLE bullet hole in the floor. You must identify the location of the shooter – and to do that you need to determine the bullet's Impact Angle. Explain how you would determine the bullet's Impact Angle based on this single bullet hole.

9. An assassination attempt was made on a government official in South America. A single shot was fired, but luckily the shooter missed, and no one was injured. You have been asked to help find the shooter's location. Two bullet holes allow you to discover the bullet's trajectory, which leads you to a high-rise building a few blocks away. You gather the information shown below and use it to calculate the shooter's height when they fired their weapon.



What was the shooter's height when they fired their weapon? Please show your work.

Shooter's Height = _____

Assume that each floor in the high-rise building is 15 feet high (the 1st floor is 0 feet high, the 2nd floor is 15 feet high, the 3rd floor is 30 feet high, etc.) On what floor of the high-rise building will you be looking for your suspect? Please show your work.

I will look on floor number _____