

Real-life Application of Trigonometry in Forensic Science

(M. Khosravi, Winter 2010)*

Name: _____

Course: _____

Class time: _____

A missing person's case with suspected foul play was reported to police authorities by the missing person's brother and a co-worker. Fred Wheeler had not reported to work or spoken with his brother for three days, which is totally out of character for him. On the few occasions when Fred did have to miss work, he would always call his boss with a legitimate excuse. Fred, his older brother Sam, and co-worker Pete have worked together for two years as auto mechanics for a local franchise. Fred and Sam would visit often, but live apart from each other. Sam lives on the opposite side of town with his wife and two young children. Fred lives alone in a small apartment complex on the second level of a two-story building. As requested, the police responded to Fred's apartment, but got no response after knocking on his door repeatedly. The two uniform officers successfully get the landlord to open Fred's apartment door and upon entering, they immediately recognize that they are inside a crime scene. Within the small one bedroom apartment, just inside the front door, the officers observe blood spatter patterns on the East living room wall. There are no signs of forced entry through the door or any windows. The officers proceed into the bedroom and observe multiple blood spatter patterns on all four walls as well as bloodstain patterns across the ceiling. The carpeted floor of the bedroom has a large North-to-South stain at the foot of the double bed. Upon entering the bathroom, there are some apparent diluted stains on the sink counter and within the sink basin. They note that there is no shower curtain in place, but there are a number of curtain hooks hanging on the rod. There is no sign of Fred Wheeler or anyone else in the apartment. Furthermore, there is no obvious weapon present, except for a .22 caliber rifle in the closet. Examination of the rifle fails to reveal any signs of reddish-brown staining and does not appear to have been recently fired.

Police investigators immediately begin to gather information about Fred Wheeler and conduct searches for him. You are the Department's expert blood spatter analyst and have been dispatched to the scene to reconstruct the violent events leading up to Fred's disappearance. Blood samples have been collected and sent to the DNA section of the laboratory to determine if the blood originates from a single donor or if there is evidence to support more than one person may have bled. Known reference standards will be obtained and submitted as soon as possible for comparison purposes.

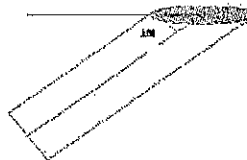
Upon arrival to the scene, you observe that there are no obvious bloodstains on the stairs leading to the second floor apartment or anywhere else outside of the apartment. You utilize a presumptive blood test kit to determine if any observed reddish-brown stains are consistent with

reactions indicating the presence of blood. Once inside, the signs of a violent encounter are immediately apparent. You begin your documentation and examination protocols in the entranceway/living room. Your initial focus is on the East wall where you observe a blood pattern approximately three feet square in the middle to upper third of the wall. You determine the directionality of the stains and select a number of stains to measure in order to determine the angle(s) of impact and the area(s) of origin. The raw data is shown in Table 1.

STAIN	WIDTH (mm)	LENGTH (mm)
1	2	4
2	1.75	3.25
3	2	3.5
4	3	4.75
5	2.25	3
6	2	3

Table 1: Measurement data of stains observed on East Wall of Living Room in Wheeler Residence.

Your initial task is to determine the *angle of impact* (AOI) for each stain and the average AOI for all six stains. You are told that you can calculate the AOI as a function of width/length ratio of each stain. Use the following picture to find that function and complete Table 2 for each stain.



AOI = _____ (write it in the function form)

STAIN	WIDTH (mm)	LENGTH (mm)	WIDTH/LENGTH RATIO	AOI
1	2	4		
2	1.75	3.25		
3	2	3.5		
4	3	4.75		
5	2.25	3		
6	2	3		
AVERAGE				

Table 2: Calculated angles of impact for stains observed on East Wall of Living Room in Wheeler Residence.

You then proceed to the bedroom and observe a great deal of *medium velocity impact spatter* as well as cast off stains on each of the walls and ceiling. Once again, you document this portion of the crime scene and take measurements of specifically selected stains as shown in Table 3. Complete this table by determining the *angle of impact* (AOI) for each stain and the average AOI for all six stains.

STAIN	WIDTH (mm)	LENGTH (mm)	WIDTH/LENGTH RATIO	AOI
1	2	3.25		
2	1.75	3		
3	1.25	2.5		
4	2	3		
5	1.5	2.25		
6	1.25	2.25		
AVERAGE				

Table 3: Calculated angles of impact for stains observed in Bedroom of Wheeler Residence.

Your involvement as a blood spatter expert in this case is particularly important to recreate the events of the crime since a victim's body was not found at this scene. As such, you must now determine a three dimensional (3D) representation to reflect the position of the victim within the bedroom at the time of the spatter. Use your results from Table 3 (use the average values) along with given information that the distance to an *area of convergence* is 85cm to draw your 3D representation of the bedroom:

The approximate distance of the *area of origin* from the ceiling for each stain can be expressed as a function of the AOI and the area of convergence. Find that function:

Area of origin = _____

Use your function to complete the following table for each stain and the averages:

STAIN	WIDTH (mm)	LENGTH (mm)	WIDTH/LENGTH RATIO	AOI	AREA OF ORIGIN	
					(cm)	(inches)
1	2	3.25				
2	1.75	3				
3	1.25	2.5				
4	2	3				
5	1.5	2.25				
6	1.25	2.25				
AVERAGE						

Table 4: Calculated area of origin for stains observed in Bedroom of Wheeler Residence.