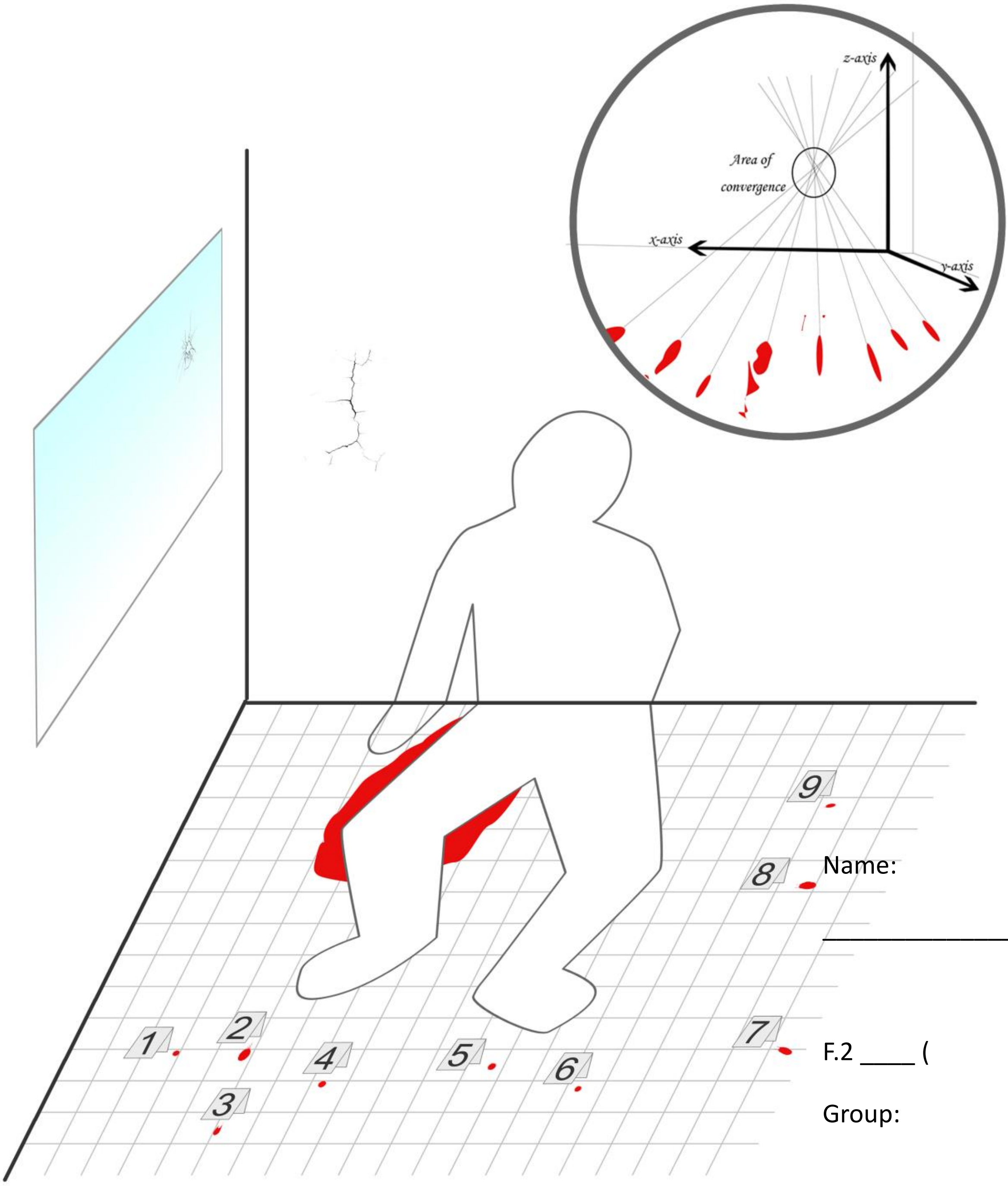
Blood Spatter

Be a Crime Scene Investigator



Name:

____

F.2 ____ (   )

Group:

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This activity is a F.2 STEM activity. It involves the participation of Mathematics, and Computer Literacy.

Date: 26th March 2019
Time: 3rd and 4th lesson periods
Venue: Hall
Group work: 4 students in each group, totally 7 groups
* Bring mobile phone (Android)) for using App Inventor

What is Forensic Science?

It is branch of applied science that use science knowledge to solve some daily problems, especially in crimes and criminals.

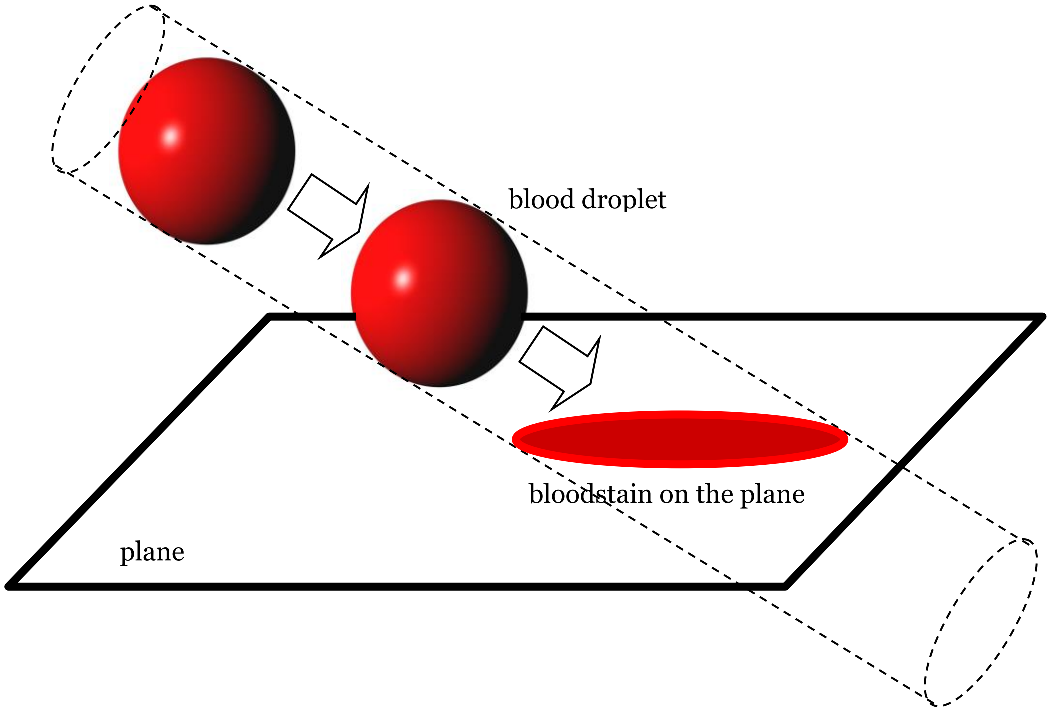
In a crime scene, anything can be a cue to solve the case. Bloodstain is an ideal piece of forensic evidence. Blood type, source, direction, velocity of the blood spurt, point of origin can tell something about the case. Scientists can use these evidences to reconstruct the crime scene and link the suspects to the crime.

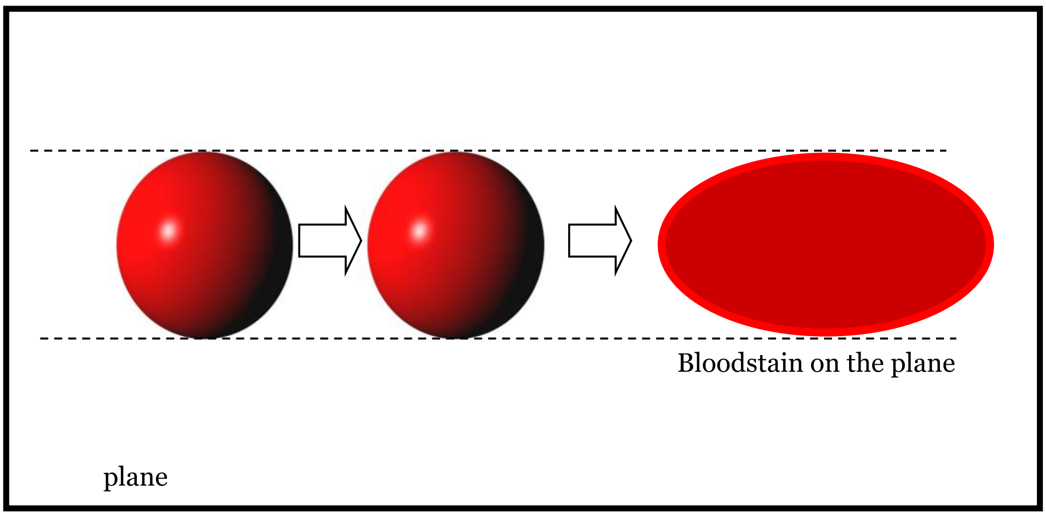
Bloodstain

When a drop of blood hit on a surface, it will form different patterns according to its velocity and the direction of hitting the surface. We can base on the size and shape of the bloodstain to determine the angle that the blood hit the surface, we called it the angle of impact.

Blood Stain Analysis	**Formation of a Bloodstain Ellipse**	**Impact Angle Affects Elongation**
https://youtu.be/3jFKZaSeNjg	https://youtu.be/M1TzSkrS2YM	https://youtu.be/8BaJwG94jQg

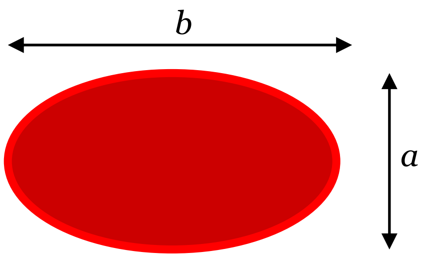
Blood Spatter Impact Angle





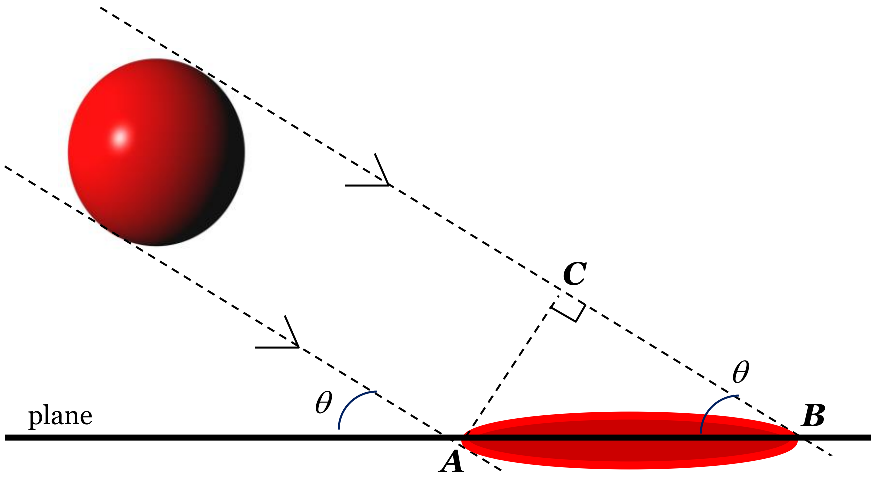
TOP VIEW

Given that the width and the length of the bloodstain on the plane are a and b respectively.



Bloodstain on the plane

Find the impact angle θ.



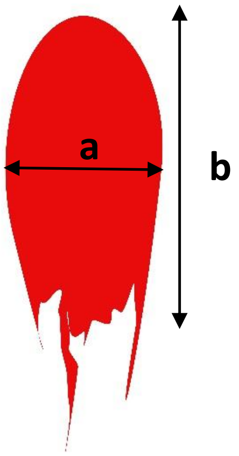
FRONT VIEW

Solution

$AB =$

$AC =$

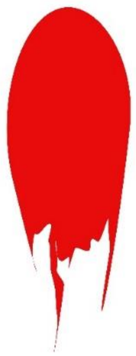
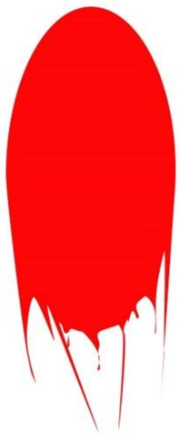
Hence, we can measure the width and the length of the bloodstains to estimate the impact angle. However, the shape of the droplet may not be a perfect ellipse like the one shown, and the width and the length can just be measured approximately.



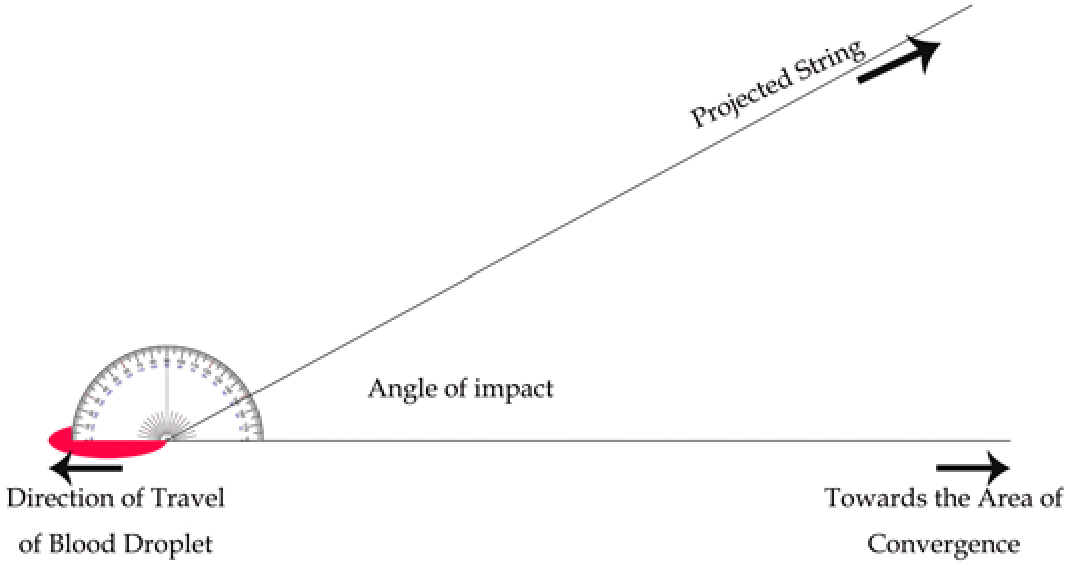
Measurement of Bloodstain Exercise

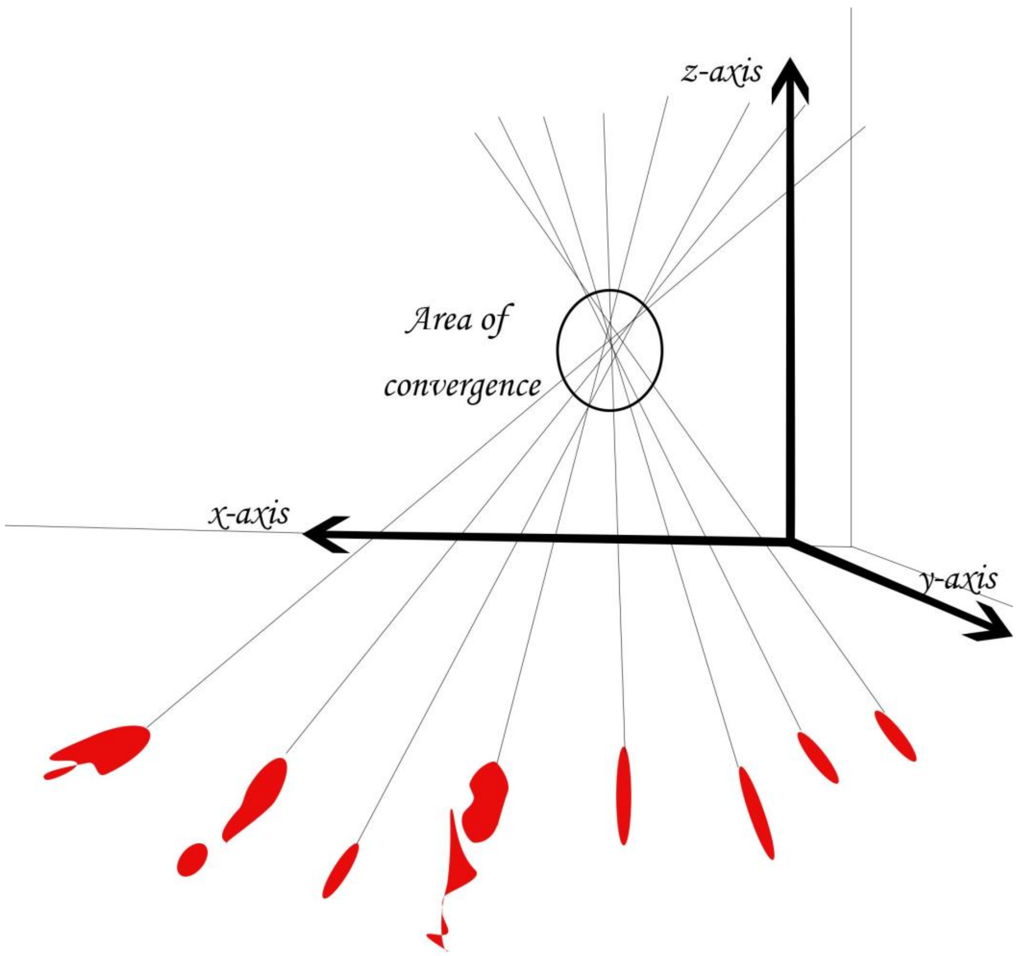
By using the equation $$\sin \theta = \frac{a \text{ (width)}}{b \text{ (length)}}$$

Fill in the following table

Blood Sample	Width (cm) (a)	Length (cm) (b)	θ
			
			
			

By calculating the angle of impact from each bloodstain on a crime scene, we can locate the area of convergence, the expected point of impact, by projecting string from each blood droplet.





https://www.geogebra.org/3d/hqzvp9dw

Scenario

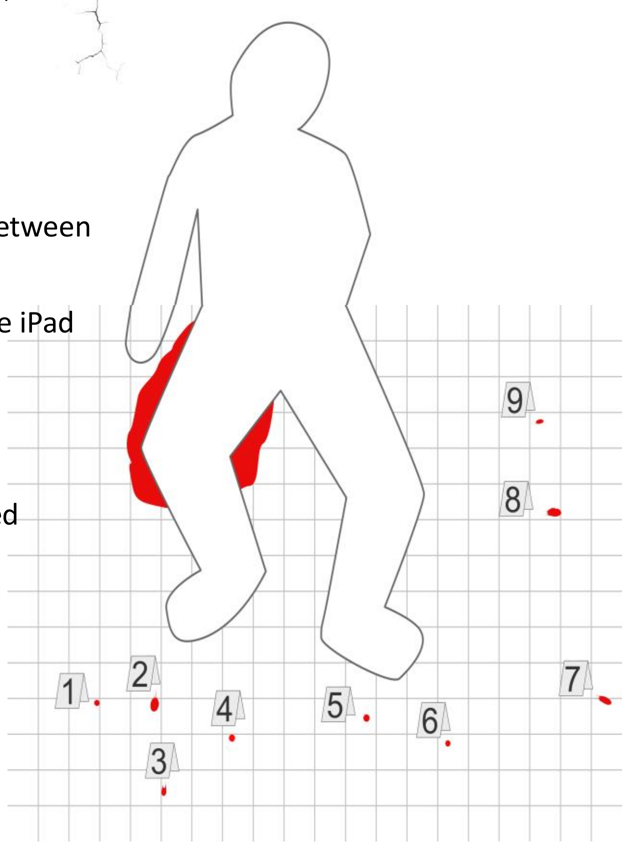
Today, you are a crime scene investigator. You have just arrived a crime scene and find a dead body on the floor. Several bloodstains are found on the floor. You have to use the cues to find the details of the crime, and tell how it happen.

Task 1

- measure the width and length of the bloodstains on the floor, calculate the angle of impact using the apps
- by using the protractor and the string given to each group, project a line according to the calculated angle from the end of the bloodstain on floor to the wall
- using a rod and plasticine to locate the nearest point of impact
- use the laser distance meter to measure the x, y, z coordinate and mark on the task sheet

Task 2

- for each projected line, measure the distance between the ends to the wall (i.e., p, q, u, w)
- enter the information in the Geogebra file in the iPad
- drag the point *P* to the position that the sum of square of distances between *P* and projection lines *S* attaining minimum
- record the coordinates of the position mentioned above and compare the coordinates of the estimated position



Material List

1 m Ruler x 2

Rod x 1

Plasticine

Clipboard x 1

Scissors x 1

Adhesive tape x 1

Colour string x 2 balls

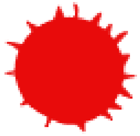
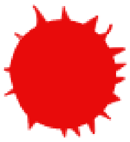
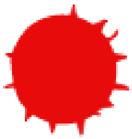
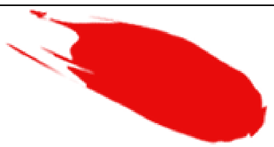
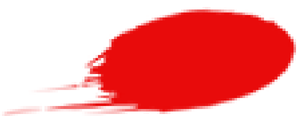
Laser Distance Meter x 1

Protractor x 2

iPad with a ‘pencil’ x 1 (for using Geogebra)

Location of the point of impact

Task 1 Visual Estimation

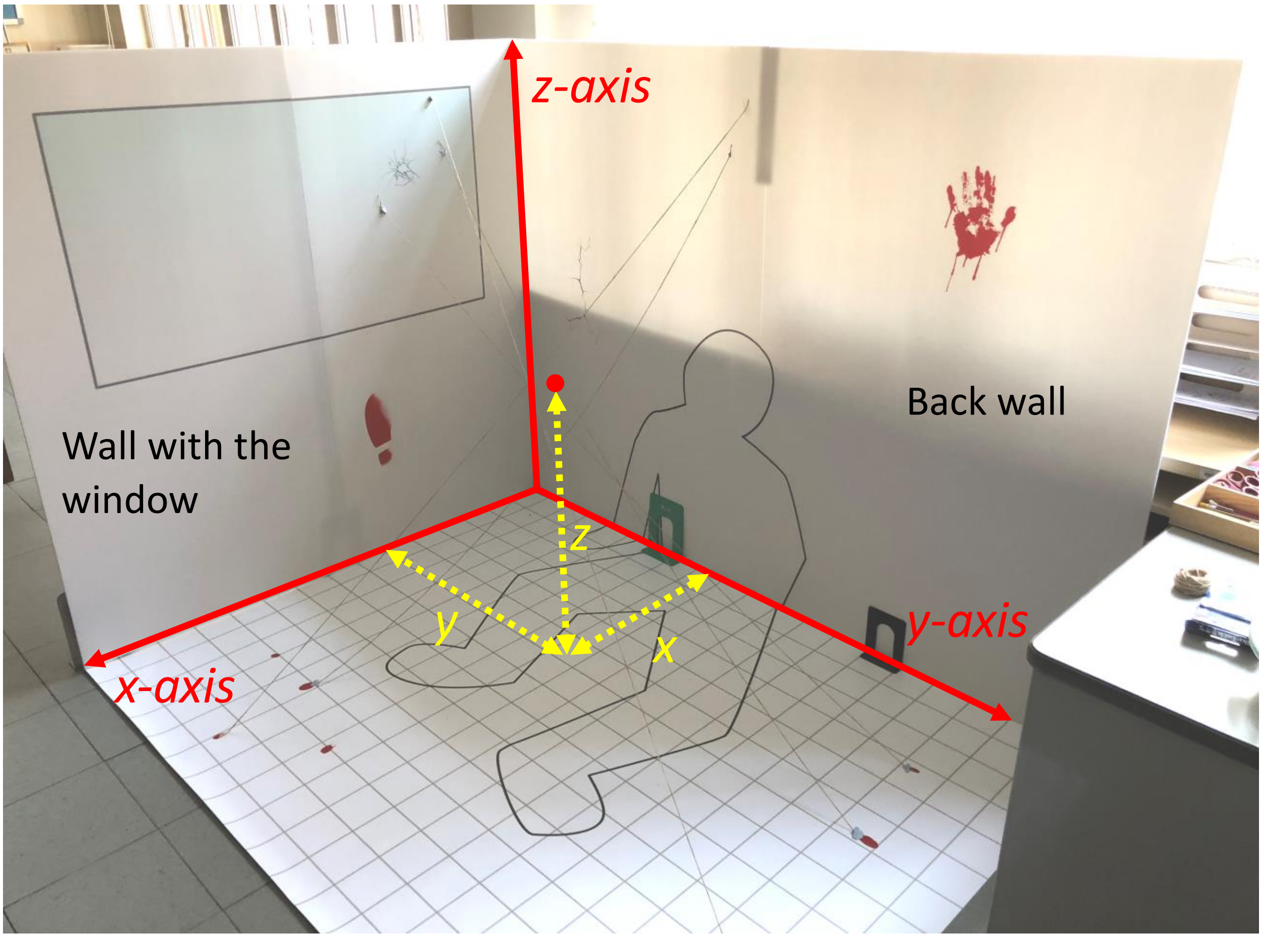
Number	Bloodstain	Need to Measure (✓ / ✗)	Width (a)	Length (b)	ϴ
1					
2					
3					
4					
5					
6					
7					
8					
9					

Step 1: For each of the bloodstain on the ground, project a string onto the wall with the window or the back wall

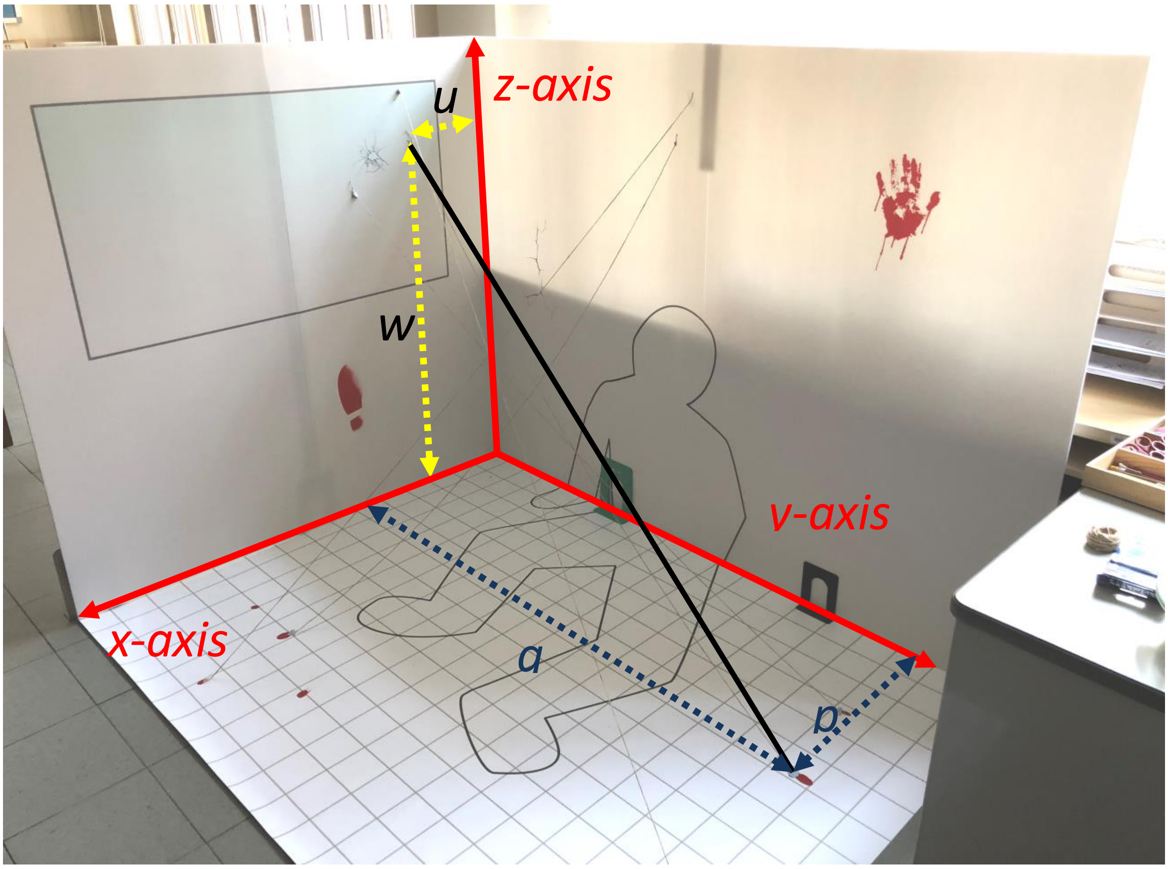
Step 2: Locate an "approximated" point of intersection of the strings by direct visualization. (You may use the rod and plasticine provided to assist you to locate the desired point.)

Step 3: Complete the following table.

	Distance (in m)
Distance from the point to the back wall (x)	
Distance from the point to the wall with the window (y)	
Height of the point (z)	



Task 2 Using GEOGEBRA



Step 1: For each of the bloodstain on the ground, measure and obtain the following data

p = Distance from the back wall to the bloodstain on the ground

q = Distance from the wall with the window to the bloodstain on the ground

Fill in the following table.

Bloodstain Number (Need to measure)	*P*	*q*	Coordinates (*p* , *q* , 0)
			A_1 = (, , 0)
			A_2 = (, , 0)
			A_3 = (, , 0)
			A_4 = (, , 0)
			A_5 = (, , 0)

(table 1)

Step 2: For each meeting point on the wall, measure and obtain the following data

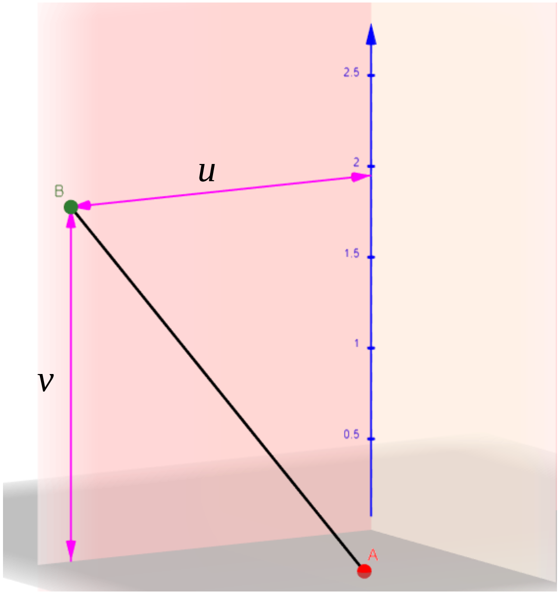
u = Distance from the meeting point of the string and the wall to the edge between two walls

v = Height of the meeting point of the string and the wall

The coordinates of the meeting point *B* should be expressed accordingly as below:

Case 1

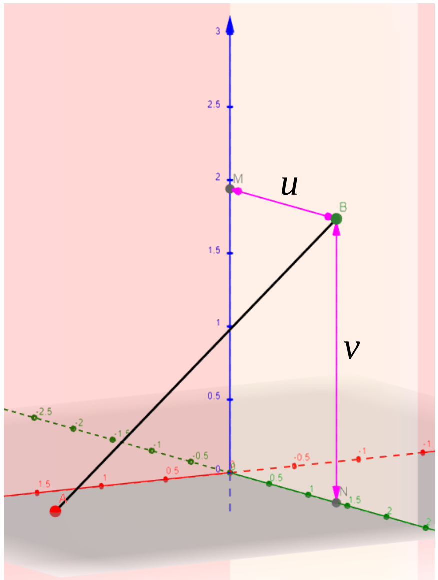
B lies on the wall with window



Coordinates of *B* = (*u* , 0 , *v*)

Case 2

B lies on the back wall



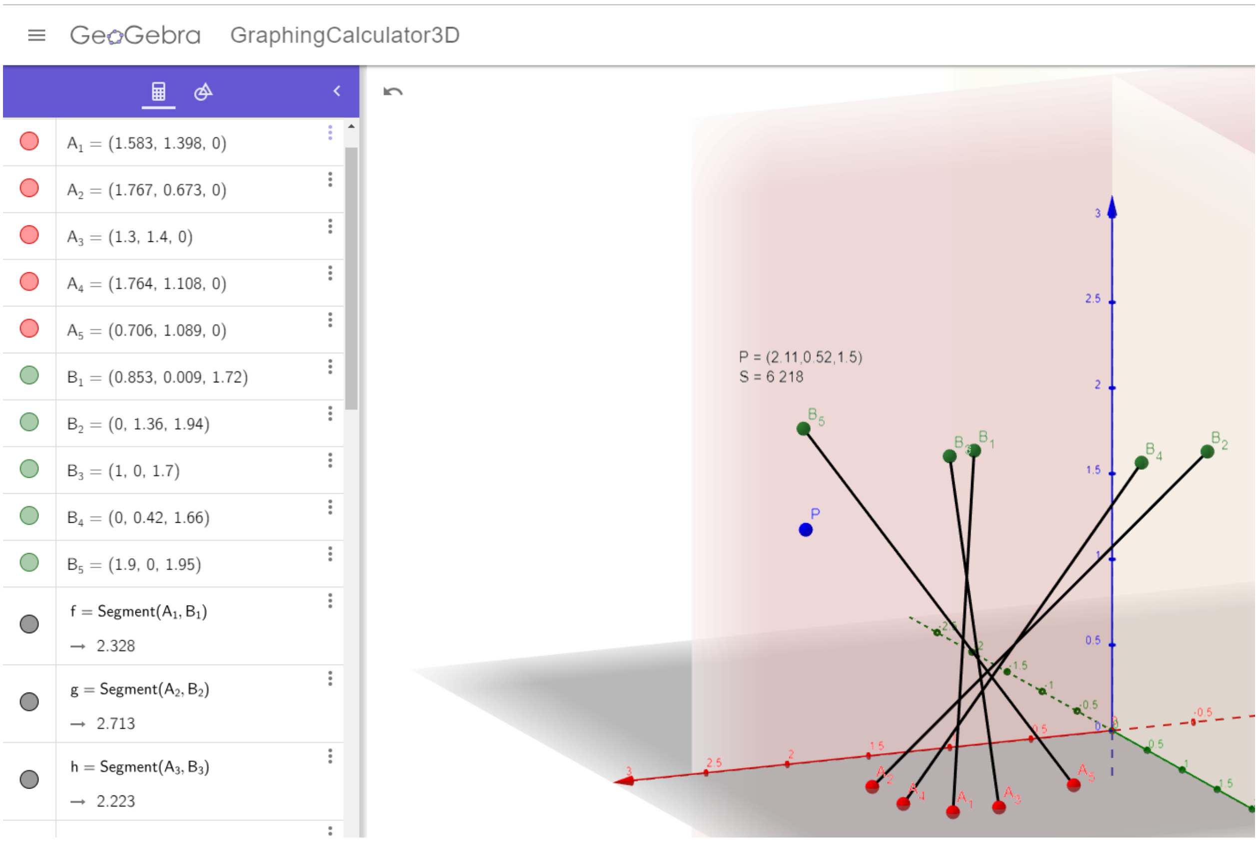
Coordinates of *B* = (0 , *u* , *v*)

Fill in the following table. Note that the bloodstain number should following the same order as in table 1.

Bloodstain Number (Need to measure)	*u*	*v*	Coordinates
			B_1 = (, ,)
			B_2 = (, ,)
			B_3 = (, ,)
			B_4 = (, ,)
			B_5 = (, ,)

(table 2)

Step 3: Take an iPad and input the 10 coordinates obtained above to the Geogebra file.



Step 4: Drag the point *P* towards the **best** position of the point of impact. That is, try to drag the point to the position such that the value of $\boldsymbol{S}$ attaining its **minimum** value; where $\boldsymbol{S}$ is the sum of the square of distances between the point *P* and projection lines.

(a) Write down your results

The coordinates of the **best** position of the point of impact	
The corresponding value of $\boldsymbol{S}$	

(b) Compare the best position and the approximated position found on P.10, are the results being the same? Why?

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(c) Comment on two methods above for finding the point of impact.

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Definition of *S*

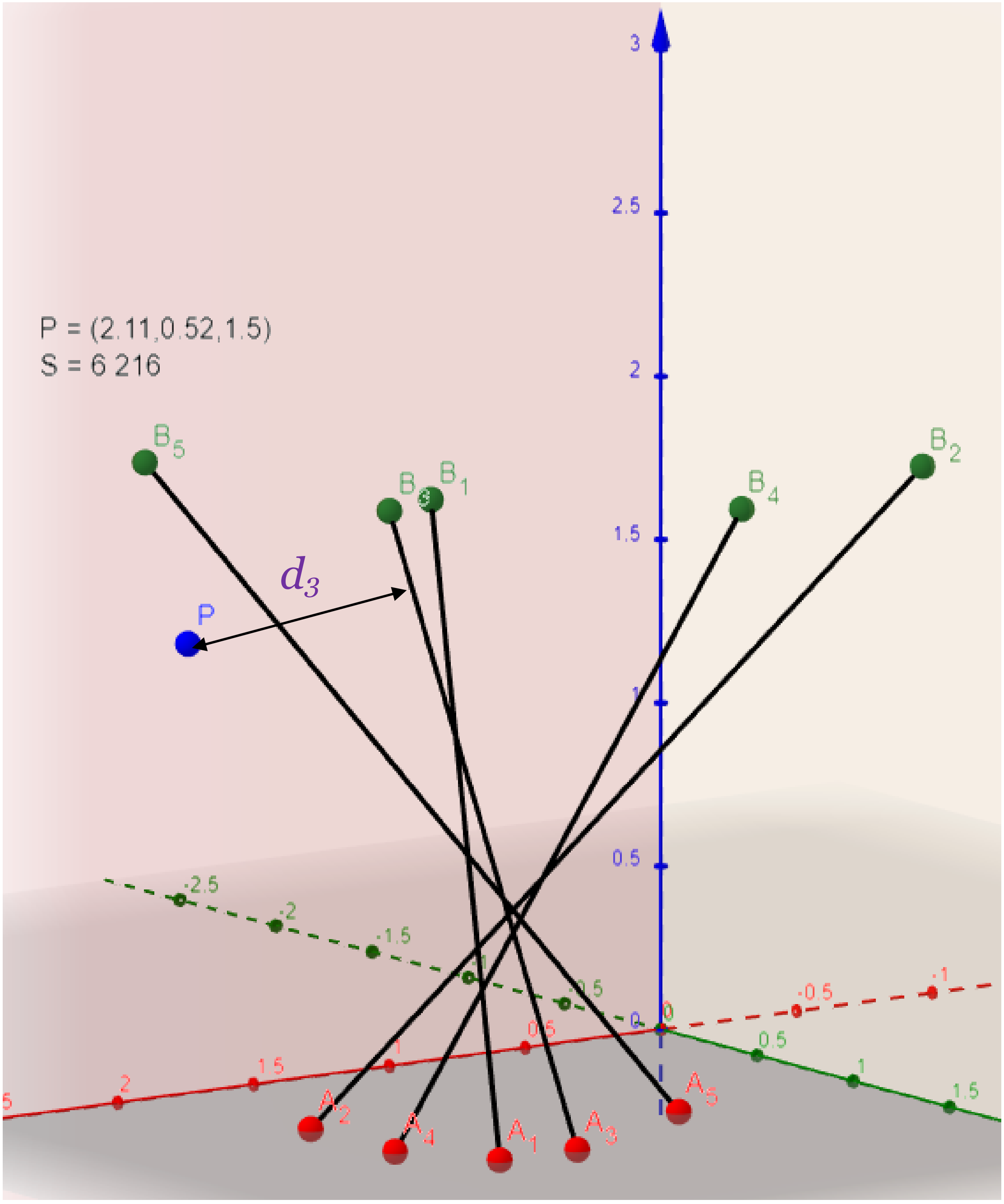
d_1 = distance between *P* and A_1B_1

d_2 = distance between *P* and A_2B_2

d_3 = distance between *P* and A_3B_3

d_4 = distance between *P* and A_4B_4

d_5 = distance between *P* and A_5B_5



$$S = d_1{}^2 + d_2{}^2 + d_3{}^2 + d_4{}^2 + d_5{}^2$$