

# Forensics – Lab

## Point of Origin

Name \_\_\_\_\_

Period \_\_\_\_\_

### Introduction:

In the previous labs, you determined the angle of impact and area of convergence for blood spatter. Now you can use that information and the Law of Tangents to calculate the height of the wound, the point of origin, on the individual.

### Background:

Blood spatter analysis helps crime-scene investigators reconstruct what happened at the crime scene. Using only blood spatter analysis, you may be able to recognize the events leading up to the crime. Although crime scene investigators may arrive at the crime scene after the victim and witnesses are no longer present, they still need to determine what happened. Often several witnesses give different accounts of the crime. Which witness is providing an accurate description of what really happened?

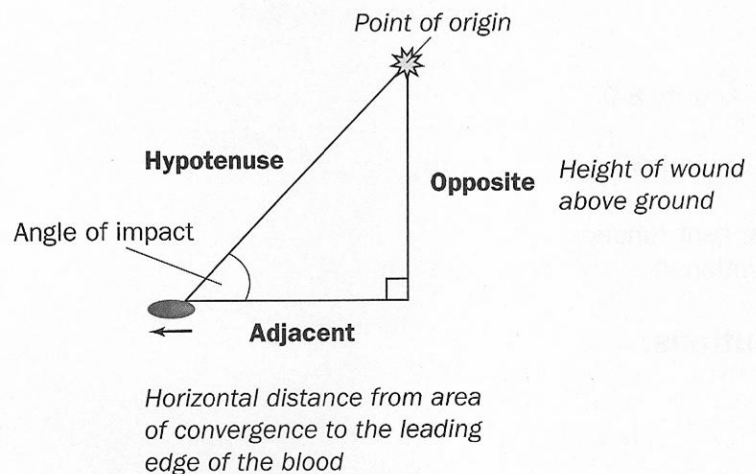
During the investigation, the crime-scene investigators need to determine if the evidence, in this case the blood spatter, matches the description given by the witnesses, the suspect(s), and the victim(s). In domestic abuse cases, the victim of domestic abuse may tell a false story to try to protect the abusing partner. A victim may state that a head injury occurred as a result of falling down the stairs. However, if the blood spatter patterns are inconsistent with this type of injury, then what type of injury did cause the blood spatter? What actually happened? Is the witness lying? Further investigation is required when the blood spatter evidence tells a different story than the witness's account of the incident.

In this lab, you will analyze blood spatter in three dimensions. By noting the shape of the droplet of blood, you will be able to note the direction in which the blood was moving. The size of the blood spatter will provide some indication of the velocity of the blood when it hit the surface. By examining at least two drops of blood spatter, you will be able to determine where the injured person was located when the injury occurred in two dimensions (line so convergence). You can easily measure the distance from the area of convergence to the drop of blood. If you want to determine the point of origin, or height from the impact surface, you will need to make some calculations. By measuring the width and length of a single drop of blood, you can determine the angle of impact. By using the Law of Tangents, you can calculate the height from which the blood fell, or the point of origin for the blood.

### Math Review:

#### Right triangle

- Contains one  $90^\circ$  angle
- The hypotenuse is the longest side of a triangle, opposite the  $90^\circ$  angle (right angle)
- The opposite side to an angle is the side directly opposite the angle of interest
- The adjacent side to an angle is the side closest to the angle that is not the hypotenuse



### Objectives:

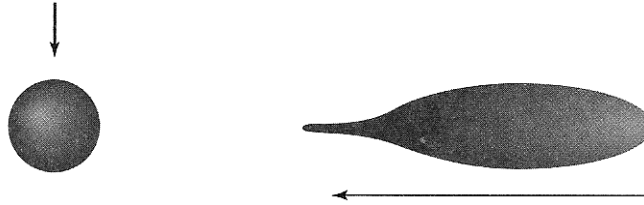
- Determine the direction of blood flow based on the shape of the droplet.
- Use line of convergence to help determine the position of the victim when the wound was inflicted.
- Calculate the angle of impact for individual drops of blood spatter.
- Use the Law of Tangents to calculate the height above floor level where the wound was inflicted.

### Materials: (per individual)

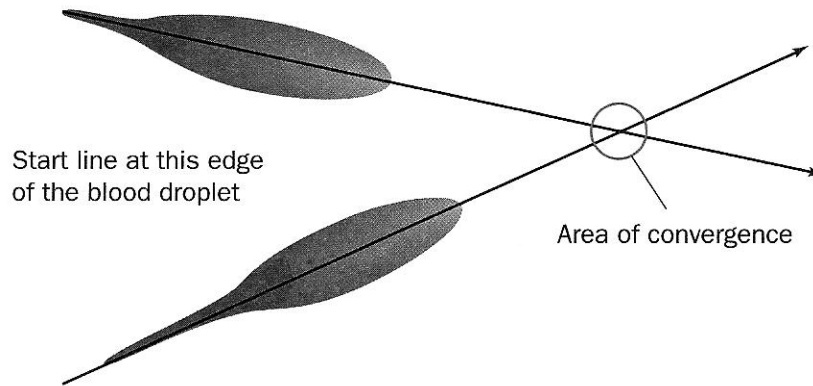
- 1 metric ruler
- 2 colored pencils
- Calculator

**Procedures:**

1. Determine the direction of blood flow in the drops that follow with an arrow next to the droplet.
  - a. If the blood drop is circular, then the blood fell at a 90° angle.
  - b. If it is not circular, then the angle of impact was less than 90°.
  - c. The elongated end of a drop of blood points to the direction in which the blood was moving.

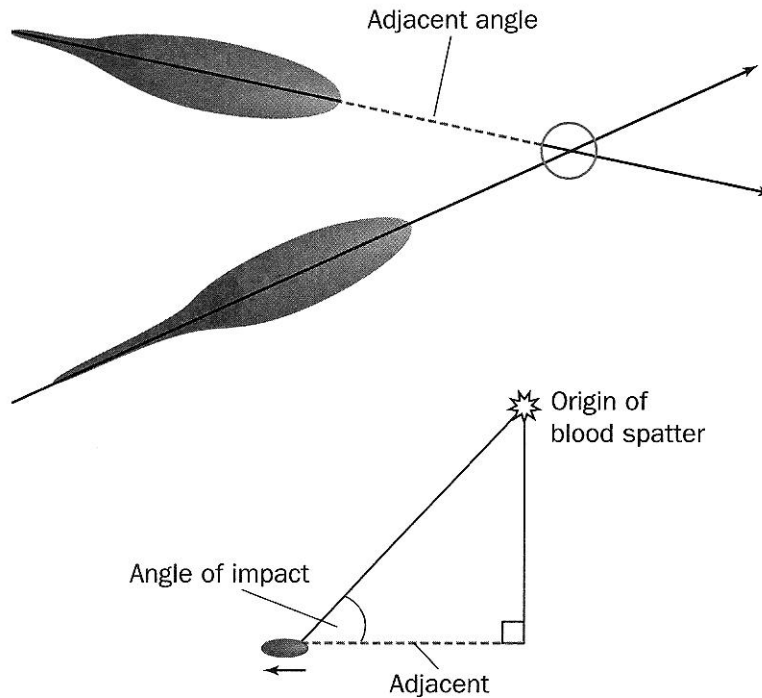


2. From several drops of blood, determine the area of convergence by drawing lines through each of the blood droplets and noting where the lines intersect.



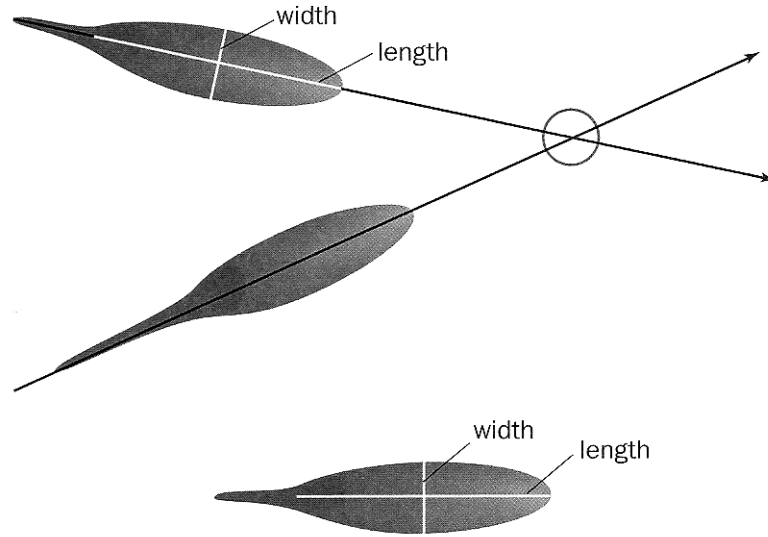
3. Once you have determined the area of convergence, you will measure the distance from the area of convergence to the edge of the drop of blood when it first impacted a surface. The distance is indicated by the dotted line.

*Recall the diagram of a right triangle. The dotted line represents the adjacent side of the angle of impact.*



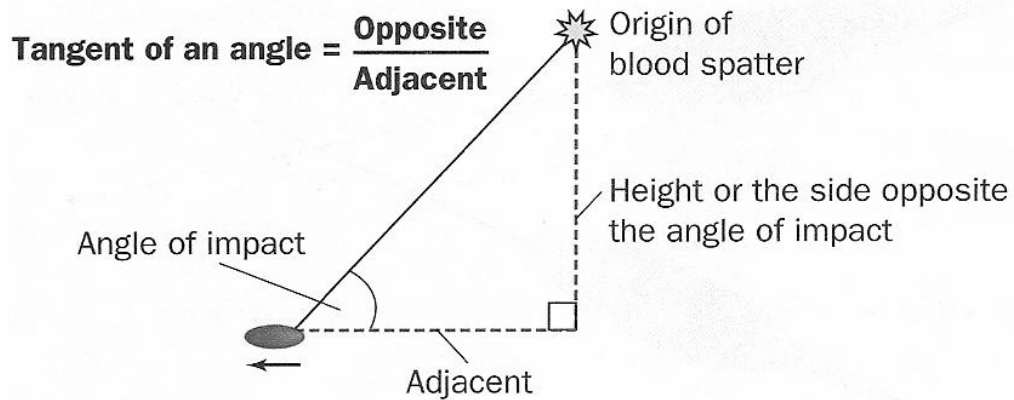
4. Next determine the angle of impact for each droplet of blood.
  - a. Select one of the blood droplets and determine the angle of impact for that drop of blood.
  - b. To calculate the angle of impact, you will need to use the Law of Sines.
  - c. Remember, when you measure the length of the blood droplet, do not include the thin extension of the leading edge (tail).

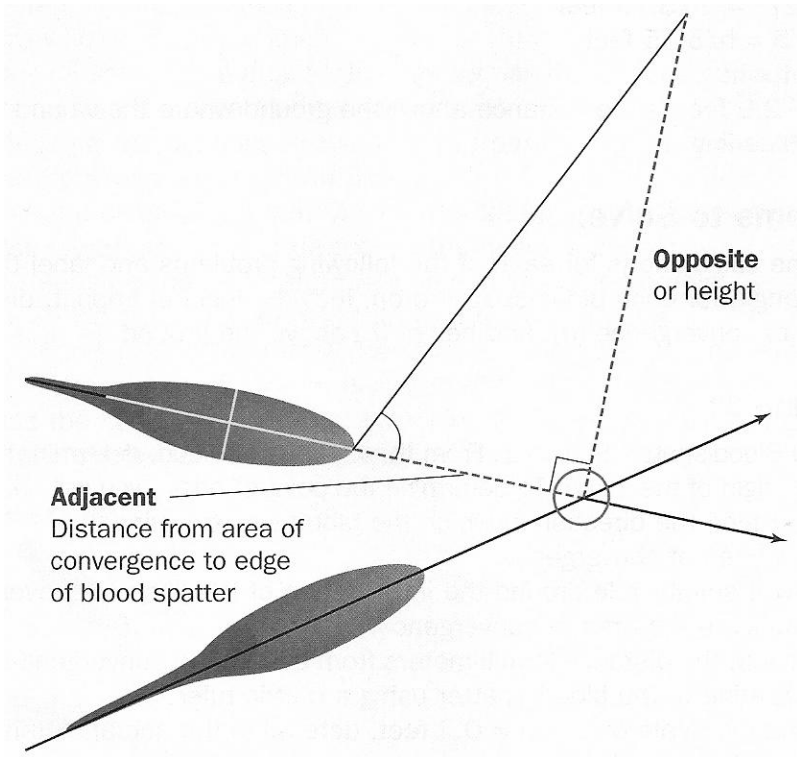
*Sin of the angle of impact = width of the blood / length of the blood drop*



$\text{Sin of the angle} = \text{width} / \text{length} = 14/45 = 0.3111$   
 $\text{Sin of angle} = 0.3111$   
 Determine the inverse sine -----2<sup>nd</sup> sin (0.3111)  
 Impact angle = 18°

5. Using the Law of Tangents to solve for height.
  - a. Going back to the right triangle and adding the angle of impact, we can determine the height from where the blood originated.
  - b. The height of the source of blood is the side opposite the angle of impact.
  - c. To solve for the height (or side opposite the angle of impact), we apply the Law of Tangents.



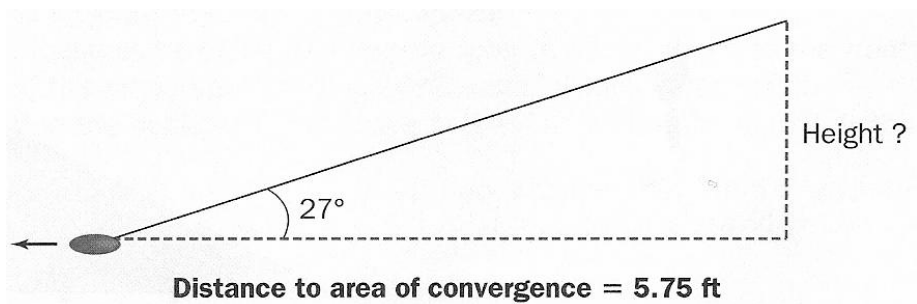


$$\text{Tangent of angle of impact} = \text{opposite} / \text{adjacent} = \text{height} / \text{distance}$$

$$\text{Height} = \text{tangent of angle} \times \text{distance}$$

**Example:**

Crime-scene investigators noted blood spatter on the floor of the kitchen. The investigators drew lines of convergence and measured the distance from the area of convergence to the front edge of a drop of blood. That distance was recorded as 5.75 feet. After measuring the length and width of the blood droplet and using the Law of Sines, it was determined that the angle of impact was 27 degrees. The police wanted to determine the point of origin, or the height from the floor where the person was bleeding.



**Solution:**

$$\tan = \text{opposite} / \text{adjacent} = \text{height} / \text{distance}$$

or

$$\text{Tangent of blood-spatter angle} = \text{height of wound} / \text{distance from blood to area of convergence}$$

$$\tan 27^\circ = \text{height if wound} / \text{distance}$$

$$\tan 27^\circ = \text{height} / 5.75 \text{ ft}$$

Solving for height:

$$\text{height} = \tan 27^\circ \times 5.75 \text{ ft}$$

$$\text{height} = 2.9 \text{ ft}$$

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**Point of Origin**

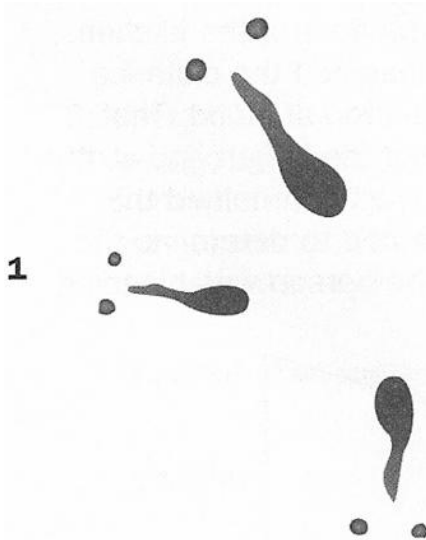
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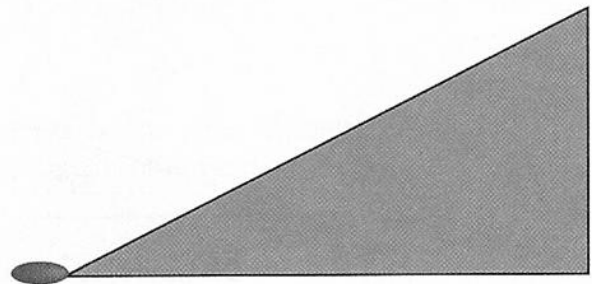
**Directions:** Make the calculations for each of the following problems and label the right triangle for each blood-spatter drop. Include the angle of impact, distance to area of convergence, and height above the ground.

**Problem 1:**

1. Determine the direction in which the blood was traveling.
2. Draw lines of convergence.
3. Draw a small circle around the intersection to indicate the area of convergence.
4. Measure the distance in millimeters from the area of convergence to the front edge of the blood spatter using a metric ruler.
5. Using the scale of 1 mm = 0.2 feet, determine the actual distance.
6. Using blood droplet 1, determine the angle of impact:
  - a. Measure the width and length of the blood droplet.
  - b. Divide the width by the length (width / length).
  - c. Determine the angle of impact. (use the inverse sin function)
7. Determine the point of origin or height of the source of blood droplet 1. (use Law of Tangents)



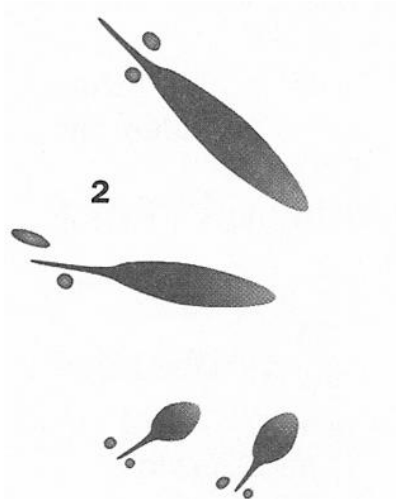
Blood droplets are drawn to scale but length of adjacent side is scaled to 1 mm = .2 feet



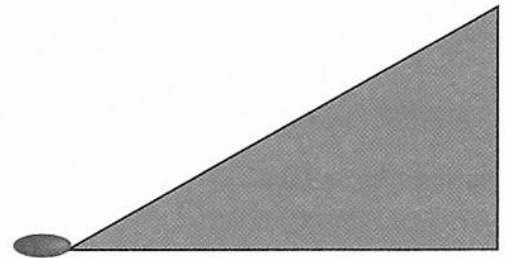
**Problem 2:**

A 30-year-old man was found shot in the head in his garage. The suspect claims he was being attacked and shot the victim in self defense.

1. Determine the direction in which the blood was traveling.
2. Draw lines of convergence.
3. Draw a small circle around the intersection to indicate the area of convergence.
4. Measure the distance in millimeters from the area of convergence to the front edge of the blood spatter using a metric ruler.
5. Using the scale of 1 mm = 0.3 feet, determine the actual distance.
6. Using blood droplet 1, determine the angle of impact:
  - a. Measure the width and length of the blood droplet.
  - b. Divide the width by the length (width / length).
  - c. Determine the angle of impact. (use the inverse sin function)
7. Determine the point of origin or height of the source of blood droplet 1. (use Law of Tangents)



Blood droplets are drawn to scale but length of adjacent side is scaled to 1 mm = .3 feet



**Problem 3:**

A victim was found at the foot of a ladder with a chest wound. What is the approximate height of his wound when he was shot?

1. Determine the direction in which the blood was traveling.
2. Draw lines of convergence.
3. Draw a small circle around the intersection to indicate the area of convergence.
4. Measure the distance in millimeters from the area of convergence to the front edge of the blood spatter (droplet #3) using a metric ruler.
5. Using the scale of 1 mm = 1.5 feet, determine the actual distance.
6. Using blood droplet 3, determine the angle of impact:
  - a. Measure the width and length of the blood droplet.
  - b. Divide the width by the length (width / length).
  - c. Determine the angle of impact. (use the inverse sin function)
7. Determine the point of origin or height of the source of blood droplet 3. (use Law of Tangents)

