

## BLOODSTAIN PATTERN ANALYSIS

### DESCRIPTION OF SESSION

This session provides participants with an understanding of bloodstain pattern analysis and how the study of the size, shape, and location of bloodstains can be used to determine the physical events that gave rise to their origin.

### CATEGORIES

- Exploring: Law Enforcement
- Exploring: Science
- U.S. Department of Education: Law, Public Safety, Corrections & Security
- U.S. Department of Education: Government & Public Administration

### OBJECTIVES

By the end of this session, participants will be able to:

- List the components of human blood.
- Identify the mechanisms by which blood spatter patterns are created.
- Describe how the surface texture of an object affects the shape of individual bloodstains.
- Describe the directly proportional relationship between stain diameter and dropping height.
- Create and interpret transfer patterns.
- Measure the length and width of bloodstains.
- Calculate the impact angle of bloodstains.

### SUPPLIES

- (1) computer with internet access

For each participant:

- (1) eye dropper or pipette
- (1) bottle of stage blood or red tempura paint
- (1) package of white 8½-by-11-inch card stock
- (1) meter stick
- (1) metric ruler
- (1) cake pan or pie plate
- Household objects (fork, knife, sponge, hammer, wrench, screwdriver, etc.)
- (1) scientific calculator
- **Impact Angle Determination Practice** activity sheet (PDF)
- **Impact Angle Determination Practice answer key** (PDF)

## PREPARATION

See Activity 6 for suggestions of speakers who could attend the meeting or places where participants could visit, and make arrangements as needed.

## WEBSITES

- “Bloodstain Tutorial” (J. Slemko Forensic Consulting): [www.bloodspatter.com/bloodstain-tutorial](http://www.bloodspatter.com/bloodstain-tutorial)—Overview of bloodstain pattern analysis.
- “A Simplified Guide to Bloodstain Pattern Analysis” (National Forensic Science Technology Center): [www.forensicsciencesimplified.org/blood/how.html](http://www.forensicsciencesimplified.org/blood/how.html)—Overview of bloodstain pattern analysis.

## VIDEOS

**Reminder:** Any time you use an outside source, be sure you follow the content owner’s or website’s permission requirements and guidelines.

These videos were chosen because they illustrate important aspects of the forensic science discipline being studied in this session. **Note:** Some of the content in the case studies is geared toward a mature audience. Advisors should review these videos before showing them to ensure that they are age appropriate for the post.

- “Blood, Part 1–True Blood: Crash Course Anatomy & Physiology #29” (CrashCourse): [www.youtube.com/watch?v=HQWlcSp9SIs](http://www.youtube.com/watch?v=HQWlcSp9SIs)—Anatomy and physiology of blood.
- “Bloodstain Pattern Analysis” (MPR News): [www.youtube.com/watch?v=kxAawVezJz4](http://www.youtube.com/watch?v=kxAawVezJz4)—Interview with forensic scientist.
- “The Science of Blood Spatter” (48 Hours): [www.youtube.com/watch?v=Olwvyns0vLAG](http://www.youtube.com/watch?v=Olwvyns0vLAG)—Demonstration of potential causes of blood spatter.
- “How Surface Texture Affects Bloodstain Patterns” (Biodynamics Engineering Inc.): [www.youtube.com/watch?v=3fqz4qWqaX0](http://www.youtube.com/watch?v=3fqz4qWqaX0)
- *Forensic Files: Invisible Intruder* (FilmRise): [www.youtube.com/watch?v=Ff\\_In9LR\\_wl&list=PLFtpZ659RpvH-DHFFOrVIRSHCYXW1CmQA](http://www.youtube.com/watch?v=Ff_In9LR_wl&list=PLFtpZ659RpvH-DHFFOrVIRSHCYXW1CmQA)—Case study No. 1.
- *Medical Detectives: Second Shot at Love* (Forensic Spider): [www.youtube.com/watch?v=mtVyQRcbJM4](http://www.youtube.com/watch?v=mtVyQRcbJM4)—Case study No. 2.
- “Matthew Welling trial” (saukvalleynews): [www.youtube.com/watch?v=MMoSnnY9KZA](http://www.youtube.com/watch?v=MMoSnnY9KZA)—Crime scene investigator testifies about blood evidence.
- “Jodi Arias trial” (Gray Hughes): [www.youtube.com/watch?v=swrR4d7Cn3A&t=296s](http://www.youtube.com/watch?v=swrR4d7Cn3A&t=296s)—Blood spatter expert testifies about blood evidence.

## RESOURCES

The following links are to websites that contain information about bloodstain pattern analysis. These would be good resources for Advisors to review if they would like to go into greater depth on this topic.

- [www.iabpa.org/](http://www.iabpa.org/)—International Association of Bloodstain Pattern Analysts
- [www.swgstain.org/](http://www.swgstain.org/)—Scientific Working Group on Bloodstain Pattern Analysis

**ADVISOR NOTE:** Make sure you add time in your activities for viewing and discussing videos with the Explorers. These videos are currently not built into the session plan so you will need to choose those that best complement your activities and plans for this topic.

**ADVISOR NOTE:** Text in italics should be read aloud to participants. As you engage your post in activities each week, please include comments, discussions, and feedback to the group relating to **Character, Leadership, and Ethics**. These are important attributes that make a difference in the success of youth in the workplace and in life.

## ACTIVITIES

### Introduction

Say to Explorers: *Bloodstain pattern analysis is a discipline of forensic science that examines bloodstain patterns at crime scenes. The size, shape, and distribution of bloodstains are examined in order to determine the physical events and mechanisms that gave rise to their origins. The examination of bloodstain patterns is a critical component of crime scene reconstruction as these patterns can assist in determining the:*

- *Two-dimensional area of convergence and three-dimensional area of origin*
- *Type and direction of impact*
- *Object(s) that produced bloodstain patterns*
- *Number of blows, shots, etc., that occurred*
- *Position of victim(s), assailant(s), or objects at a crime scene during a blood shedding event*

*Additionally, bloodstain pattern analysis can support or refute statements made by victims, suspects, or witnesses.*

To provide more background to the Explorers, you may wish to share some of the materials listed under “Websites” and “Videos.”

After Explorers have conducted Activities 1-4, debrief as a large group.

### Activity 1

#### How Bloodstain Patterns Are Created

Have participants watch as many videos as time permits from the Midwest Forensics Resource Center at [www.ameslab.gov/mfrc/bpa-videos](http://www.ameslab.gov/mfrc/bpa-videos). These videos illustrate a number of different mechanisms that create bloodstain patterns.

## **Activity 2**

### **Effect of Dropping Distance on Stain Diameter**

Have each Explorer follow this procedure:

- Fill an eye dropper or pipette with stage blood or red tempura paint.
- Drop single drops of blood onto white card stock from 10 cm, 50 cm, and 1 m and allow them to dry.
- Measure the diameter of each stain.

*Ask: What correlation can you draw between stain diameter and dropping height?*

## **Activity 3**

### **Transfer Patterns**

Have each Explorer follow this procedure:

- Pour enough blood or tempura paint into a cake pan or pie plate to completely cover the bottom.
- Choose one of the household objects, dip it into the blood or paint, and press it onto a clean piece of card stock.
- Re-wet other parts of the same object and press onto clean white card stock. Observe how different parts of the same object can leave remarkably different patterns.
- Repeat this for each of the selected household objects. Observe the transfer patterns.

Ask participants whether or not they would be able to ascertain the nature of each object if it were used in an actual criminal case.

## **Activity 4**

### **Impact Angle Determination**

Show the video “Blood Stain Analysis: Calculating the Area of Convergence and the Area of Origin” (National Forensic Science Technology Center):

[www.youtube.com/watch?v=3jFKZaSeNjg](http://www.youtube.com/watch?v=3jFKZaSeNjg).

Have participants complete the **Impact Angle Determination Practice** activity sheet. Then review the worksheet with participants using the Impact Angle Determination Practice answer key.

## **Activity 5**

### **Case Studies**

Show the *Forensic Files* and/or *Medical Detectives* episodes listed under “Videos” to the Explorers and discuss how bloodstain pattern evidence helped in the investigation.

## **Activity 6**

### **Speaker or Visit**

If possible, make arrangements for one of the following activities in order to provide Explorers with a real-world look at the profession of forensic science.

- Arrange for a visit to a local, county, or state crime laboratory with an emphasis on the forensic biology section.
- Reach out to a crime laboratory or crime scene investigation unit and arrange for a bloodstain pattern analyst to talk to participants.
- Have participants attend a trial where bloodstain pattern analysis evidence is being presented.
- Have participants research the Sam Sheppard case. This is one of the most infamous cases in the history of bloodstain pattern analysis.

### **ADVISOR NOTE**

Some sample questions are below. They are designed to help the participants apply what they have learned to their own interests. You are welcome to use these questions or develop your own questions that relate to your post or specific focus area.

### **REFLECTION**

- *Discuss the anatomy and physiology of blood.*
- *What are some of the mechanisms that create blood spatter? Describe how each mechanism affects the size, shape, and distribution of each bloodstain pattern.*
- *Define transfer pattern.*
- *Describe the relationship that exists between the length and width of a bloodstain and how it can be used as part of reconstructing a crime.*
- *Identify some of the health hazards that could be associated with doing this type of work.*

### **ADVISOR AND OFFICER REVIEW**

After the meeting, address the following:

- Identify what was successful about the meeting.
- Identify what needed improvement.
- Schedule an officer and Advisor planning meeting to prepare for the next post meeting or activity.

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# Impact Angle Determination Practice Worksheet

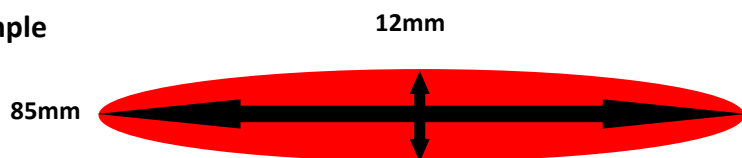
Examiner Name \_\_\_\_\_

Date \_\_\_\_\_

Period \_\_\_\_\_

**Directions:** For each of the following simulated bloodstains determine the impact angle and record the answer in the space provided. Measure all stains in millimeters and each measurement should be estimated to the nearest tenth of a millimeter. Be sure to show your math and include the degree sign in your answer.

## Example



$$\sin^{-1} \text{ of } 12\text{mm}/85\text{mm} = 8.1^\circ$$

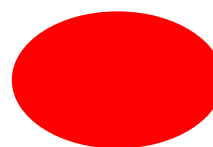
$$\sin^{-1} \text{ of width/length} = \text{Impact Angle}$$

1.



Impact Angle \_\_\_\_\_

2.



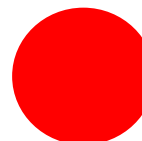
Impact Angle \_\_\_\_\_

3.



Impact Angle \_\_\_\_\_

4.



Impact Angle \_\_\_\_\_

5.



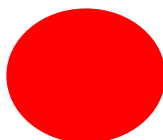
Impact Angle \_\_\_\_\_

6.



Impact Angle \_\_\_\_\_

7.



Impact Angle \_\_\_\_\_

8.



Impact Angle \_\_\_\_\_

9.



Impact Angle \_\_\_\_\_

10.



Impact Angle \_\_\_\_\_

# Impact Angle Determination Practice Worksheet

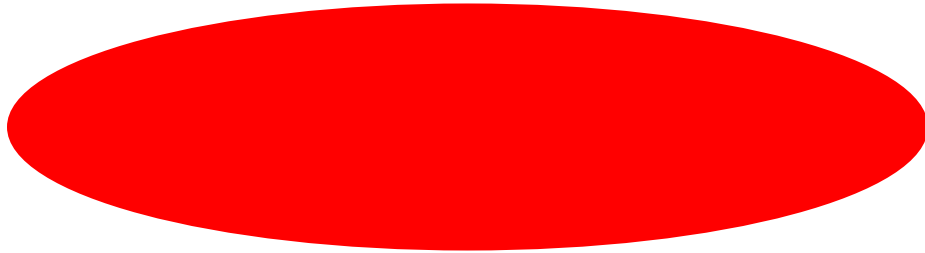


$\text{Sin}^{-1}$  of Width/Length = Impact Angle

Answer Key



# #1



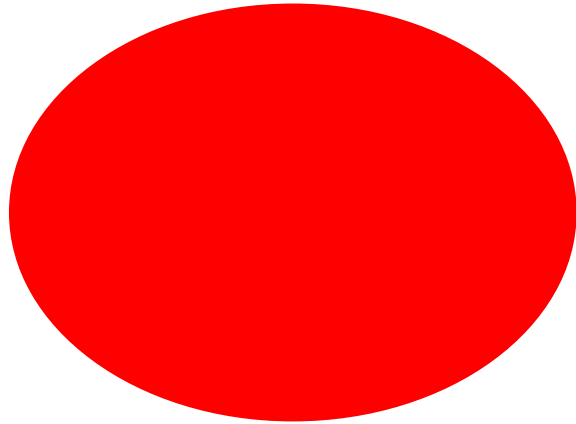
**Width = 11mm**

**Length = 40.5mm**

**$11\text{mm}/40.5\text{mm} = 0.2716$**

**$0.2716 \text{ Sin}^{-1} = 15.8^\circ$**

# #2



**Width = 18mm**

**Length = 28mm**

**$18\text{mm}/28.5\text{mm} = 0.6315$**

**$0.6315 \text{ Sin}^{-1} = 39.1^\circ$**

# #3



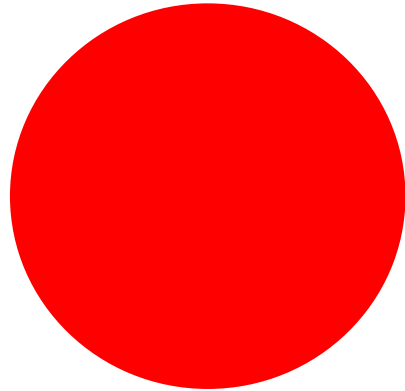
**Width = 8mm**

**Length = 55mm**

**8mm/55mm = 0.1455**

**0.1455  $\text{Sin}^{-1}$  = 8.4°**

**#4**



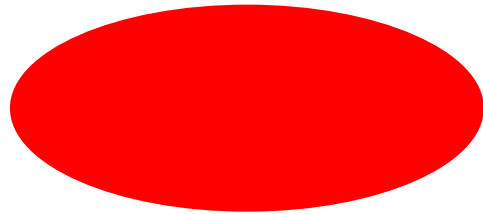
**Width = 18.5mm**

**Length = 14mm**

**18.5mm/19mm = 0.9736**

**0.9736 Sin<sup>-1</sup> = 76.8°**

**#5**



**Width = 15.5mm**

**Length = 37mm**

**15.5mm/37mm = 0.4189**

**0.4189 Sin<sup>-1</sup> = 24.8°**

# #6



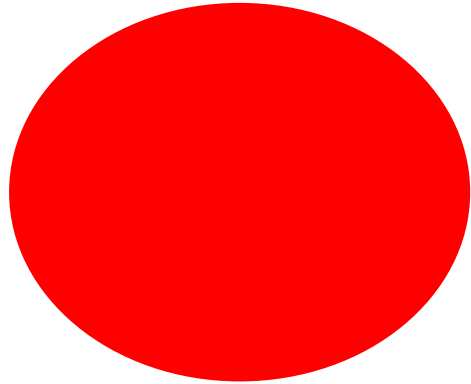
**Width = 5mm**

**Length = 52mm**

**5mm/52mm = 0.0962**

**0.0962 Sin<sup>-1</sup> = 5.5°**

**#7**



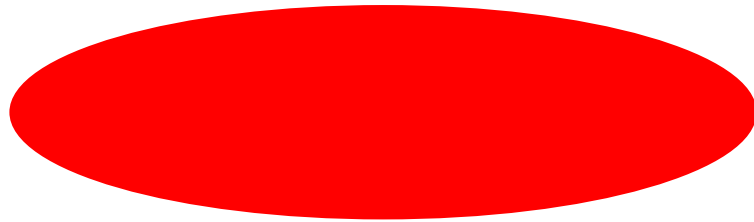
**Width = 5mm**

**Length = 52mm**

**5mm/52mm = 0.0962**

**0.0962 Sin<sup>-1</sup> = 5.5°**

**#8**



**Width = 7mm**

**Length = 22mm**

**7mm/22mm = 0.318181818**

**0.318181818 Sin<sup>-1</sup> = 18.6°**



# #9



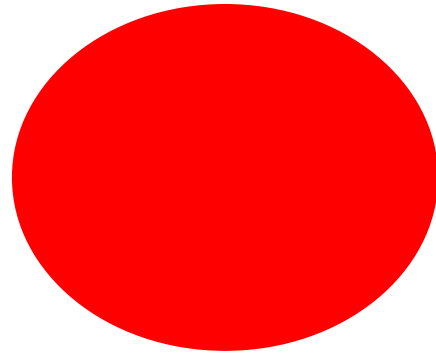
**Width = 5.5mm**

**Length = 39mm**

**$5.5\text{mm}/39\text{mm} = 0.141025641$**

**$0.141025641 \text{ Sin}^{-1} = 8.1^\circ$**

# #10



**Width = 11.5mm**

**Length = 13mm**

**11.5mm/13mm = 0.884615385**

**0.884615385 Sin<sup>-1</sup> = 62.2°**