

### Blood Stain Pattern Analysis

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**Date/Time Lesson to be taught:** Thursday, October 17 – Friday, October 18, 2013

**Course Description:** Forensic Science is a course that uses a structured and scientific approach to the investigation of crimes of assault, abuse and neglect, domestic violence, accidental death, homicide, and the psychology of criminal behavior. Students will learn terminology and investigative procedures related to crime scene, questioning, interviewing, criminal behavior characteristics, truth detection, and scientific procedures used to solve crimes. Using scientific methods, students will collect and analyze evidence through case studies and simulated crime scenes such as fingerprint analysis, ballistics, and blood spatter analysis. Students will learn the history, legal aspects, and career options for forensic science. (\$130.295) At Richardson High School, Forensic Science is a senior level elective course.

**Name:** Forensic Science

**Grade Level:** 12<sup>th</sup>

**Honors or Regular:** Regular

**Lesson Source:** Science Spot (<http://sciencespot.net/Pages/classforsci.html#blood>)

Greensburgsalem

([http://webcache.googleusercontent.com/search?q=cache:GR\\_bsZmolMsJ:www.greensburgsalem.org/cms/lib4/PA01001409/Centricity/Domain/79/07\\_Blood\\_Spatter\\_Lab\\_B.doc+&cd=1&hl=en&ct=clnk&gl=us&client=firefox-a](http://webcache.googleusercontent.com/search?q=cache:GR_bsZmolMsJ:www.greensburgsalem.org/cms/lib4/PA01001409/Centricity/Domain/79/07_Blood_Spatter_Lab_B.doc+&cd=1&hl=en&ct=clnk&gl=us&client=firefox-a))

Blood Spatter Analysis

(<http://webcache.googleusercontent.com/search?q=cache:JxsTs-ucsQUJ:www.chs.d211.org/science/pettyjohnjk/Forensics/Blood%2520spatter/Blood%2520Spatter%2520Analysis.doc+&cd=1&hl=en&ct=clnk&gl=us&client=firefox-a>)

*Forensic Science: An Introduction* by Richard Saferstein

**Concepts:** Students will be introduced on how forensic scientists can use blood spatters to draw conclusions from crime scenes. Different methods of detecting blood such as light source, blood reagent test (Phenolphthalein, HemaStix, luminol, fluorescein, and Leuco Crystal Violet) will be addressed with careful attention to the chemistry of luminol. Forensic terminology such as spatter, satellite spatters, and spines, area of convergence, area of origin used for bloodstain pattern analysis will be expected to be utilized in the communication of demos and findings. Students will understand how physics, chemistry, and biology uniquely in forensics.

**Objectives:** Students will be able to

1. Communicate their findings using bloodstain pattern analysis terminology.

2. Study blood stains and predict height of source of injury and angle of blood droplet impact.
3. Deduce how the diameter of a blood droplet is effected by height of injury and angle of impact.
4. Describe how luminol works to detect blood from a chemistry perspective.

**Texas Essential Knowledge and Skills:**

(F.12) Knowledge and skills Scientific processes: The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

- (A) demonstrate safe practices during laboratory and field investigations

(F.9) The student analyzes blood spatter at a simulated crime scene. The student is expected to:

- (A) Analyze blood stain patterns based on source, direction, and angle of trajectory; and  
(B) Explain the method of chemically isolating an invisible blood stain using reagents such as luminol.

(F.11) The student explores serology laboratory procedures in forensic science. The student is expected to:

- (A) Explain forensic laboratory procedures to determine if a stain detected in a crime scene is blood

**English Language Proficiency Standards (learning strategies, listening, speaking, reading or writing)**

(74.4 C.3) Cross-curricular second language acquisition/speaking. The ELL speaks in a variety of modes for a variety of purposes with an awareness of different language registers (formal/informal) using vocabulary with increasing fluency and accuracy in language arts and all content areas. ELLs may be at the beginning, intermediate, advanced, or advanced high stage of English language acquisition in speaking. In order for the ELL to meet grade-level learning expectations across the foundation and enrichment curriculum, all instruction delivered in English must be linguistically accommodated (communicated, sequenced, and scaffolded) commensurate with the student's level of English language proficiency. The student is expected to:

- (E) share information in cooperative learning interactions;  
(H) narrate, describe, and explain with increasing specificity and detail as more English is acquired.

**Materials List and Advanced Preparations:**

6 Meter Sticks, fake blood (corn starch, water, and red dye), (1)10 ft butcher paper, 6 poster boards, 6 dropper bottles, 6 rulers, 6 protractors, 30 glow sticks, 6 clipboards, 6 meter sticks, 1 measuring tape, cardboard stock, party popper

**Safety:** Goggles and plastic apron will be utilized.

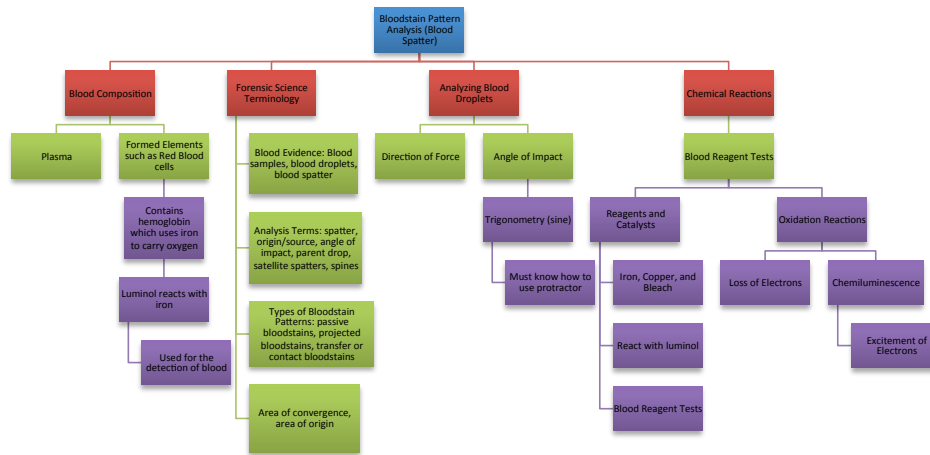
**Accommodations for Learners with Special Needs (ELL, Special Ed, 504, GT, etc.):**

Printed notes will be given to the students with fill-in the blanks in order to facilitate note taking.

Printed direction of the demo labs will be given to students.

Demonstration of demos will be made for visual clarification.

**Knowledge Package**



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**Comment [1]:** Revision of the Knowledge Package was made to include a section on chemical reactions which is imperative to understanding the mechanism of luminol to detect blood.

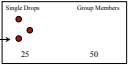
ENGAGEMENT (Slides 1-19)		Time: 30 Minutes
What the Teacher Will Do	Probing/Eliciting Questions	Student Responses and Misconceptions
<p>Good morning! Today we will see how physics, biology, and chemistry intersect in the field of forensics, specifically when analyzing blood spatters.</p> <p>This part of the Engagement will be partly a lecture. It is necessary to introduce the new terminology in such a way as it must be used for the upcoming demos and case study.</p> <p>Before proceeding to BPA slide</p>	<p>How can we use physics in forensics?</p> <p>Let's take a look at a video from a forensics research lab at UC – Davis.</p> <p>What did you notice about some of the blood spatters on the video</p> <p>How could a blood spatter be utilized in a crime scene?</p>	<p>Students might already be exposed to blood spatter analysis, thus it might be mentioned. I won't give a verbal response, as the video will proceed thereafter.</p> <p>[It was messy]</p> <p>The spatters looked different depending on what weapon was utilized. We'll see what affect blood spatters in a little bit.</p> <p>[It allows us to see the specific location of the crime.]</p> <p>There are several additional information that a blood spatter reveals:</p> <ul style="list-style-type: none"> <li>-Type and velocity of weapon</li> <li>-Number of blows</li> <li>-Handedness of assailant (right or left-handed)</li> <li>-Position and movements of the victim and assailant during and after the attack</li> <li>-Which wounds were inflicted first</li> <li>-Type of injuries</li> <li>-How long ago the crime was committed</li> <li>-Whether death was immediate or delayed.</li> </ul> <p>... We will physically see some of this displayed in our demos and case study.</p>
Blood Composition	What do you know about blood composition	[Transport of nutrients, oxygen]

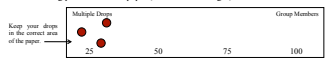
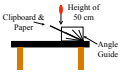
<p>Show diagram of blood composition. Emphasize blood cells and transition to hemoglobin. After going over the chart, address how blood composition leads to the cohesiveness and the viscous nature of blood.</p> <p>Go over slides 8-9. Transition to focus on luminol by showing video from CSI Miami.</p>	<p>and/roles?</p> <p>How do these properties aid in forensics?</p> <p>How do you think blood's high cohesiveness affects its interaction with surfaces?</p> <p>What happens when you dim your computer screen, it becomes dark, and you forget?</p> <p>How does luminol work?</p> <p>What are the limitations?</p>	<p>Blood has unique properties that allow the use of forensic tools to reveal the details of a crime.</p> <p>[Detection, DNA, Blood typing]</p> <p>This "stickiness" or the attractive forces between the molecules will propel blood to stay close together. Therefore the surface area covered by the blood is minimized.</p> <p>[You might think it's off] Yes, so you start clicking your mouse and key until you realize it. You can't see what's on your screen, but your programs are still running. This is how light sources and blood reagent tests work. They help us see what is difficult to see with the naked eye. It makes blood more visible.</p> <p>[It's a chemical reaction]</p> <p>[It can dilute blood.] Yes, it is also triggered by different factors such as bleach, copper, so it might be misleading. Horseradish (plant) can give false positives</p> <p>Usually luminol doesn't interfere with the DNA, but if you have a small sample</p>
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**Comment [3]:** A visual aid exploring the cohesiveness of blood versus water is needed. This can be done by using a straw. Subsequent questions about these implication must be asked.

<p>I will pass out glow sticks and ask them to deduce a hypothesis. I will ask 2 students to share.</p> <p>Bloodstain Pattern Analysis Terminology Presentation (15-19)</p> <p>Satellite spatters (outer space) analogy to help students remember.</p>	<p>How does a glow stick work?</p> <p>How does this relate back to blood?</p> <p>How has ever gotten a zit/pimple?</p>	<p>other options of detection might be better.</p> <p>[Also a chemical reaction]. There is an oxidation and thus excitement of electrons.</p> <p>[Detection]</p> <p>[EWWWW] I am not going to ask if you've popped it or not, but let's think about it. It's basically a blister, what happens when you place pressure on it. → Spatter</p>
<p><b>Evaluation/Decision Point Assessment</b></p>	<p><b>Assessment</b></p>	<p><b>Student Outcomes</b></p>
<p>How well is the class engaging?</p>	<p>Are the students attempting to answer the questions?</p> <p>What's the difference between area of convergence and area of origin?</p>	<p>Students will be challenged to think of alternative for making blood visible.</p> <p>[One is 2D and the other 3D.]</p>


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**Comment [2]:** Show video on the area of convergence and area of origin. Ask students to state what each means and then the difference. Make sure to give ample time before proceeding to slide that contains the definitions.

EXPLORATION		Time: 20 Minutes
What the Teacher Will Do	Probing/Eliciting Questions	Student Responses and Misconceptions
<p>Students will have 3 Stations. Instructions will be given at the beginning and printed on the student worksheets.</p> <p>I will give a demo demonstration of each. Special attention will be given regarding the use of the protractor, as that might be the greatest source of confusion.</p> <p>Students might have subsequent questions regarding the directions. Therefore I will be walking around to address these.</p> <p>I will ask students for their predictions before the start of the stations.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p style="text-align: center; background-color: #e67e22; color: white; margin: 0;"><b>Station 1: Single Droplets</b></p> <ul style="list-style-type: none"> <li>Label two large pieces of construction paper as shown below.</li> </ul> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; text-align: center;"> <p style="font-size: 8px;">Single Drops      Group Members</p>  <p style="font-size: 8px;">Keep your drops in the correct area of the paper.</p> <p style="font-size: 8px;">25      50</p> </div> <div style="border: 1px solid black; padding: 5px; text-align: center;"> <p style="font-size: 8px;">Single Drops      Group Members</p> <p style="font-size: 8px;">75      100</p> </div> </div> <ul style="list-style-type: none"> <li>To do the lab, put on your goggles and hold the dropper bottle upside down so that the end of it is 25 cm from the paper. GENTLY squeeze the bottle so that ONE drop of blood is released and lands in the correct location on your paper. It should NOT hit the meterstick.</li> <li>Repeat TWO more times at this height for a total of three drops.</li> <li>Continue making drops of blood on your paper, but put the drop in a different area of the paper and change the height each time.</li> <li>When you are done, analyze your results and answer the questions on your worksheet.</li> </ul> <p style="font-size: 8px; margin: 0;">Make a mistake? Use a paper towel to wipe it off your paper!</p> </div>	<p>Throughout the stations, I will be walking around asking students to make predictions before they follow throughout the stations.</p> <p>Ex: What will happen to the diameter of the blood drop you increase the height?</p>	<p>[Answers will vary] I will not correct the predictions as the stations will address this.</p>

<p><b>Station 2: Multiple Droplets</b></p> <ul style="list-style-type: none"> <li>Label a long piece of butcher paper (2-3 meters in length) as shown below.</li> </ul>  <p>Keep your drops in the correct area of the paper.</p> <ul style="list-style-type: none"> <li>To do the lab, put on your goggles and hold the dropper bottle upside down so that the end of it is 25 cm from the paper. GENTLY squeeze the bottle so that ONE drop of blood is released and lands in the correct location on your paper. The drop should NOT hit the meterstick.</li> <li>Without moving your hand, release ONE more drop onto the first drop at that height. If you make a mistake, wipe it off with a paper towel and try it again.</li> <li>Continue making drops of blood on your paper so you have three sets for each height.</li> <li>When you are done, analyze your results and answer the questions on your worksheet. Clean up your area and put away your materials before you leave class.</li> </ul> <p><b>Station 3: Angle of Impact</b></p> <ul style="list-style-type: none"> <li>You will be creating sample drop patterns created by droplets landing at different angles from the same height.</li> <li>Label five pieces of copy paper with your names and then indicate the angle for each droplet - 15°, 30°, 45°, 60°, or 75°.</li> <li>Place the first piece of paper on the clip board and align the clipboard with the 15° line. Hold the bottle of blood at a height of 50 centimeters from the top of the table.</li> <li>GENTLY squeeze the bottle so that ONE drop of blood is released and lands on the paper. Repeat two more times at this angle.</li> <li>Continue testing by dropping blood from a height of 50 centimeters at each of the other angles.</li> <li>When you are done, answer the questions on your worksheet. Clean up your area and put away your materials before you leave class.</li> </ul> 		
<p><b>Evaluation/Decision Point Assessment</b></p>	<p><b>Assessment</b></p>	<p><b>Student Outcomes</b></p>
<p>Probing questions as listed above.</p>	<p>Verbal communication. Survey if the class is ready to cleanup.</p> <p>I will ask students to retain their worksheets and review their responses as we will discuss them in class and use the information for a case study.</p>	<p>Students will feel comfortable making predictions and testing them.</p>

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**Comment [4]:** As I walk around asking probing questions, I will ask students to physically display why we can tell the direction of the impact by the tail of a blood droplet.



EXPLANATION		Time: 10 Minutes in the beginning of the next class
What the Teacher Will Do	Probing/Eliciting Questions	Student Responses and Misconceptions
<p>The Explanation will be a class discussion about the results of the Exploration with more eliciting and probing questions. Students will be asked to make educated guesses about motion affects about blood splatters.</p> <p>A video of slow-motion blood drops will be shown to confirm explanations by students.</p>	<p>What did you notice about the <u>diameter of the parent droplets</u> as you <u>increased</u> the height of the drop?</p> <p>How do the <u>spines</u> compare from the different heights?</p> <p>What did you notice about the <u>diameter of the parent droplets</u> as you <u>increased</u> the height of the drop?</p> <p>How do the <u>spines</u> compare from the different heights?</p> <p>What did you notice about the shape of the droplets as you increased the angle of the paper?</p> <p>How would you be able to determine the direction of the force just seeing a bloodstain spatter?</p>	<p>Diameter increased</p> <p>There is a greater number of spines as the height increases.</p> <p>Increased</p> <p>There were further away from the center.</p> <p>It became more distorted; The radius was a little more difficult to measure. They were more elongated.</p>  <p>The diagram shows a vertical, elongated red blood spatter. A red box is drawn around the upper portion of the spatter, with the word 'LENGTH' written vertically to its right. A smaller red box is drawn around the lower, narrower portion of the spatter, with the word 'WIDTH' written vertically below it. To the right of the spatter, a red arrow points downwards, labeled 'Direction of travel'.</p>
<b>Evaluation/Decision Point</b>	<b>Assessment</b>	<b>Student Outcomes</b>

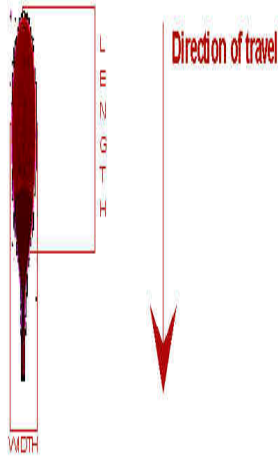
<b>Assessment</b>		
If most students were able to answer the questions successfully.	How well and with how much confidence did the students answer the questions?	Students will have a greater understanding.

ELABORATION		Time: 30 Minutes
What the Teacher Will Do	Probing/Eliciting Questions	Student Responses and Misconceptions
<p><b>Motion Demo:</b></p> <ul style="list-style-type: none"> <li>Observe how 3 different speeds affect blood spatter.                             <ul style="list-style-type: none"> <li>Size</li> <li>Shape</li> <li>Distance between the blood droplets</li> </ul> </li> </ul> <p>The four different case studies will be displayed per team. Each group will have a unique blood splatter from the same crime scene for analysis.</p>	<p>How can you use the techniques of evidence gathering to deduce a conclusion about the crime scene through blood splatter analysis?</p>	<p>Each team will have different conclusions since different exhibits will be analyzed.</p> <p>I expect students to talk about height, motion/stasis, and angle of impact.</p>
Evaluation/Decision Point Assessment	Assessment	Student Outcomes
In this group setting, students will have the opportunity to dialogue and elaborate on their conclusions based on the results.	I will be walking around per group to facilitate the discussions.	Students will participate and use forensic terminology to communicate their understanding.

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**Comment [5]:** Reduced to 20 minutes

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**Comment [6]:** Demo will not be conducted. Only probing questions

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Comment [7]: Changed to 20 minutes

EVALUATION		Time: 10 Minutes
What the Teacher Will Do	Probing/Eliciting Questions	Student Responses and Misconceptions
<p>Class will engage in discussion time as each group presents findings. This will be a presentation of the elaboration. Thus, this will give me an opportunity to measure their understanding of the terminology and the process involved to arrive at those conclusions.</p>	<p>According to your blood splatter analysis, what can you deduce about the crime scene?</p>	<p>There were 2 sites of injury. One was at a high height than the other.</p> <p>The victim ran for a while but then slowed down and started dragging the injured body part.</p> <p>The victim might have been followed as a second set of foot prints appear.</p>
	<p>How can an investigator tell the direction of travel of blood from the shape of a bloodstain?</p>	 <p>The diagram shows a vertical, elongated bloodstain. A red box is drawn around the upper portion of the stain. The word 'LENGTH' is written vertically to the right of the box, and 'WIDTH' is written horizontally below the box. To the right of the stain, a red arrow points downwards, labeled 'Direction of travel'.</p>
	<p>What is the difference between the shape of bloodstain that impacts a surface at a low angle and one that impacts at a higher angle?</p>	<p>Lower angle than 90: the blood drops are elongated.</p>
	<p>How does luminol work to detect blood?</p>	<p>Chemical reaction. Oxidation. Excitation of electrons.</p>

	T/F: Harder and less porous surfaces result in less spatter, whereas rough surfaces produce stains with more spatter and serrated edges.	True