

Forensic Science: Blood Spatter Across the Curriculum NSTA 2012

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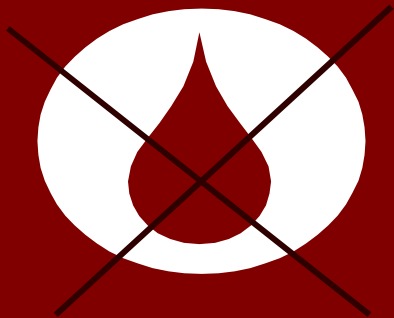
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Physical Properties of Blood

- Blood has a fairly high surface tension
- Blood is very viscous
- Blood tends to adhere to external surface
- Blood that falls from body moves as an oscillating sphere



http://www.ameslab.gov/mfrc/bpa_videos

1000 fps
1/6000 sec
640 x 1024
frame : 0
+00:00:00.000000sec

T L Laber
B P Epstein
M C Taylor

MFRC: 06-S-02
December 2007



Physical Properties of Blood

- Size of spherical blood droplet depends upon size of surface from which it falls (larger surface=more volume=larger droplet)
- Height of fall changes diameter of blood drop (closer to ground=smaller diameter)
- Blood reaches *terminal velocity* at approximately 7 feet and diameter will not increase

2000 fps
1/5000 sec
640 x 640
frame : 0
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December 2007

10 cm drop

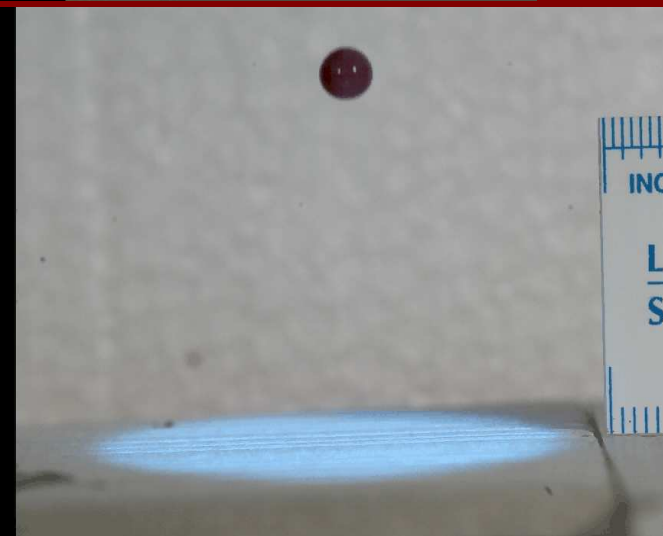


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M C Taylor

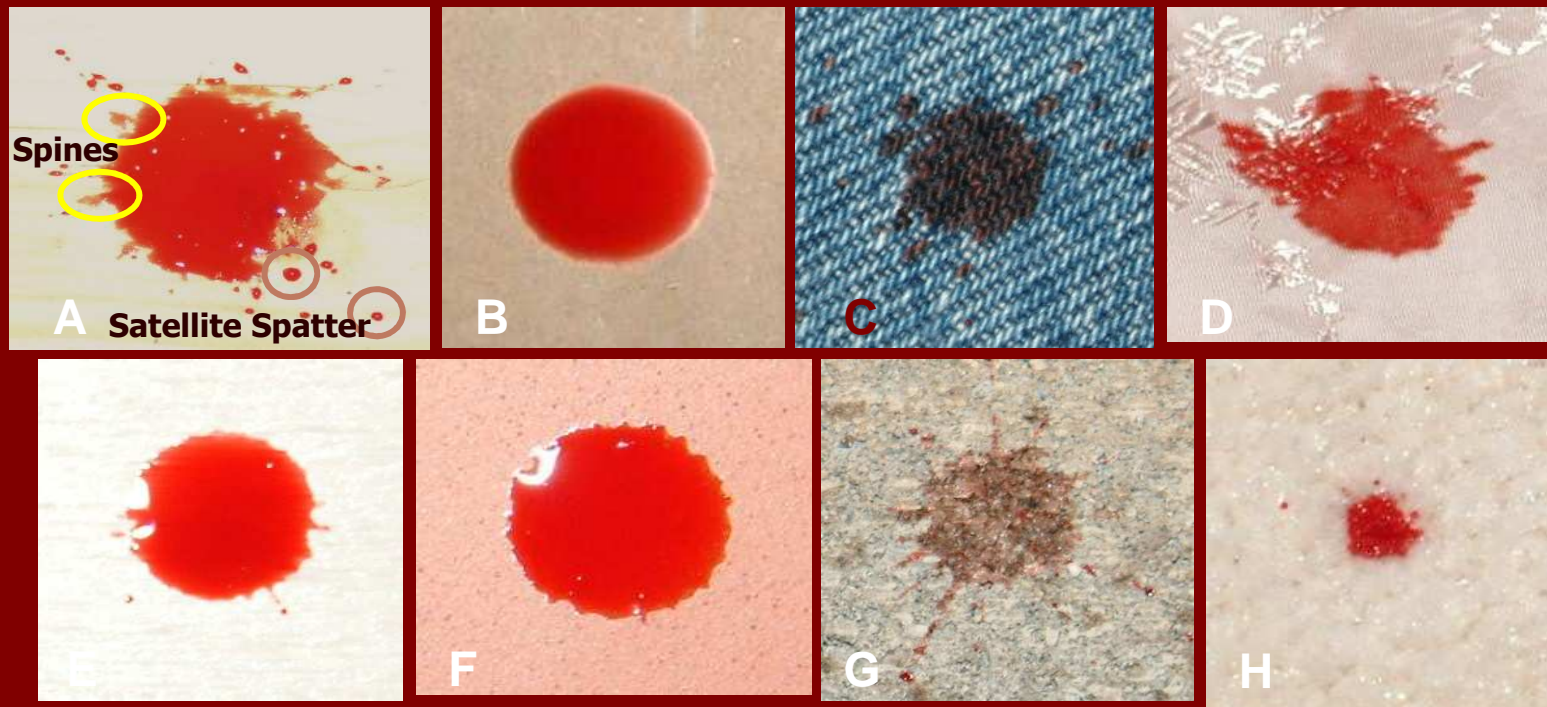
MFRC: 06-S-02
December 2007

10 0cm drop



Physical Properties of Blood

- *Spines*—protrusions from the parent blood drop
- *Satellite spatter*—smaller droplets that leave parent drop and land near it
- Disruption of surface tension and cohesive properties of blood due to type of target surface



Your Turn 😊

- Use the 'Drip and Projected Blood'
- Drip blood onto 2 surfaces
 - notecards & cloth
 - drip from 15 cm , 30 cm and 45 cm
- Discussion!

Bloodstain Pattern Categories

- *Passive stains*: move only under influence of gravity
- *Spatter stains*: arise from a force in addition to gravity
- *Altered stains*: are physically or physiologically changed

Passive Bloodstains

Vertical drips & Multiple Drips



Prints (shoe, hand, hair, etc)



Large volume

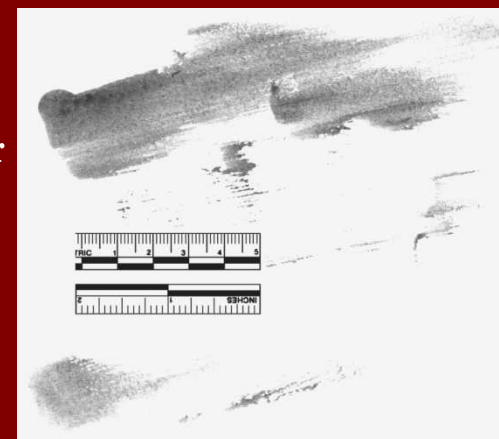
Large amount of blood hits target at one time



Flow
Natural movement of large blood deposit



Swipe
Bloodied object leaves transfer of blood showing motion



Your Turn 😊

- Vertical Drips
 - Drip blood onto notecards from 60 cm, 75 cm and 100 cm. Compare to the 15, 30 & 45 cm
 - What can you do with this? Discussion!
- Try other stains: multiple drips, swipe, prints
 - Discussion!

Spatter Bloodstains

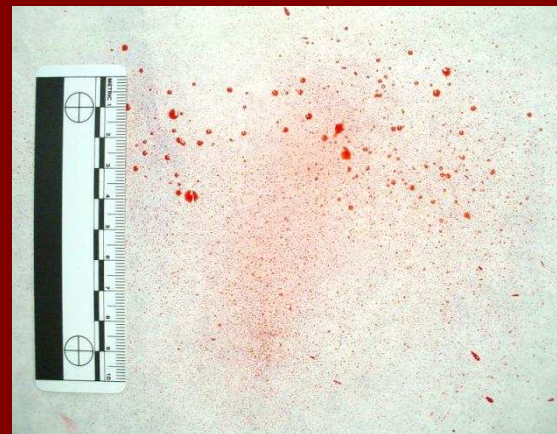
Impact Spatter Due to Blunt Force

- Result of bloodied object receiving a blow
- Must have blood on surface to create this type of pattern
- First blow does not generally produce impact stain
- Bloodstains are typically 1-4 mm in size



Spatter Bloodstains

- *Impact Spatter Due to Gunshot*
 - Bloodstains <Imm in length
 - Misty appearance
- *Cast Off*
 - Linear pattern of blood leaving weapon such as knife, bat, or hand



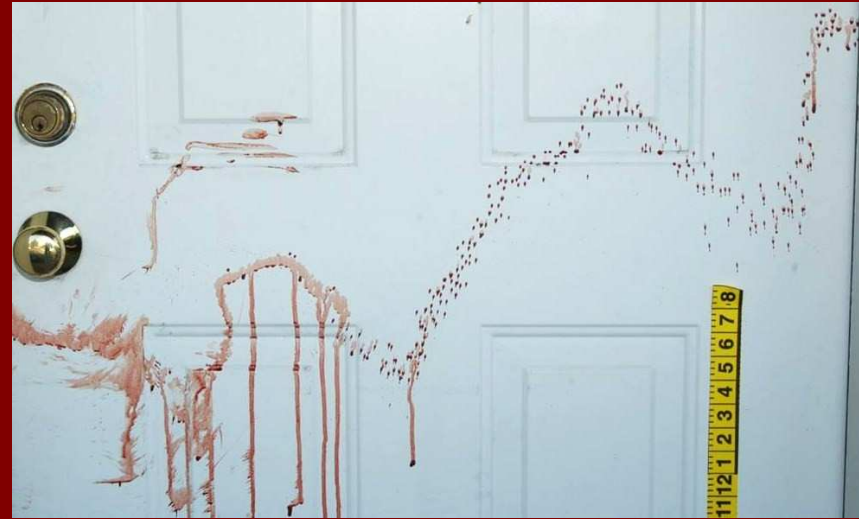
Impact Due to Gunshot



Simulating a Cast Off Pattern

Spatter Bloodstains

- *Arterial*
 - Large amount of blood under pressure
 - Arc pattern
 - Due to breach of major artery (carotid, femoral)
- *Expired*
 - Blood ejected with force from respiratory system
 - Similar pattern to impact spatter, but may contain air bubbles

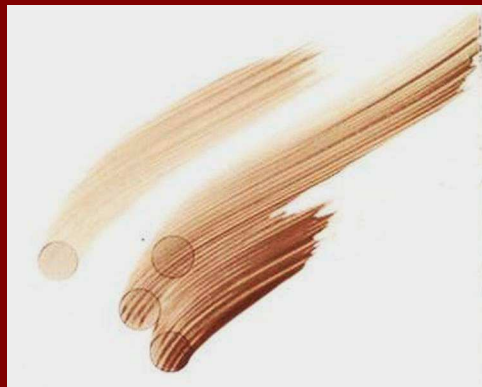


Altered Bloodstains

- Physiologically Altered Stains
 - *Insect activity*—trails
 - *Addition of foreign* (non-blood) *material*
- Physically Altered Stains
 - *Void*—absence of blood where it should be
 - *Wipe*—existing bloodstain altered by secondary motion through it



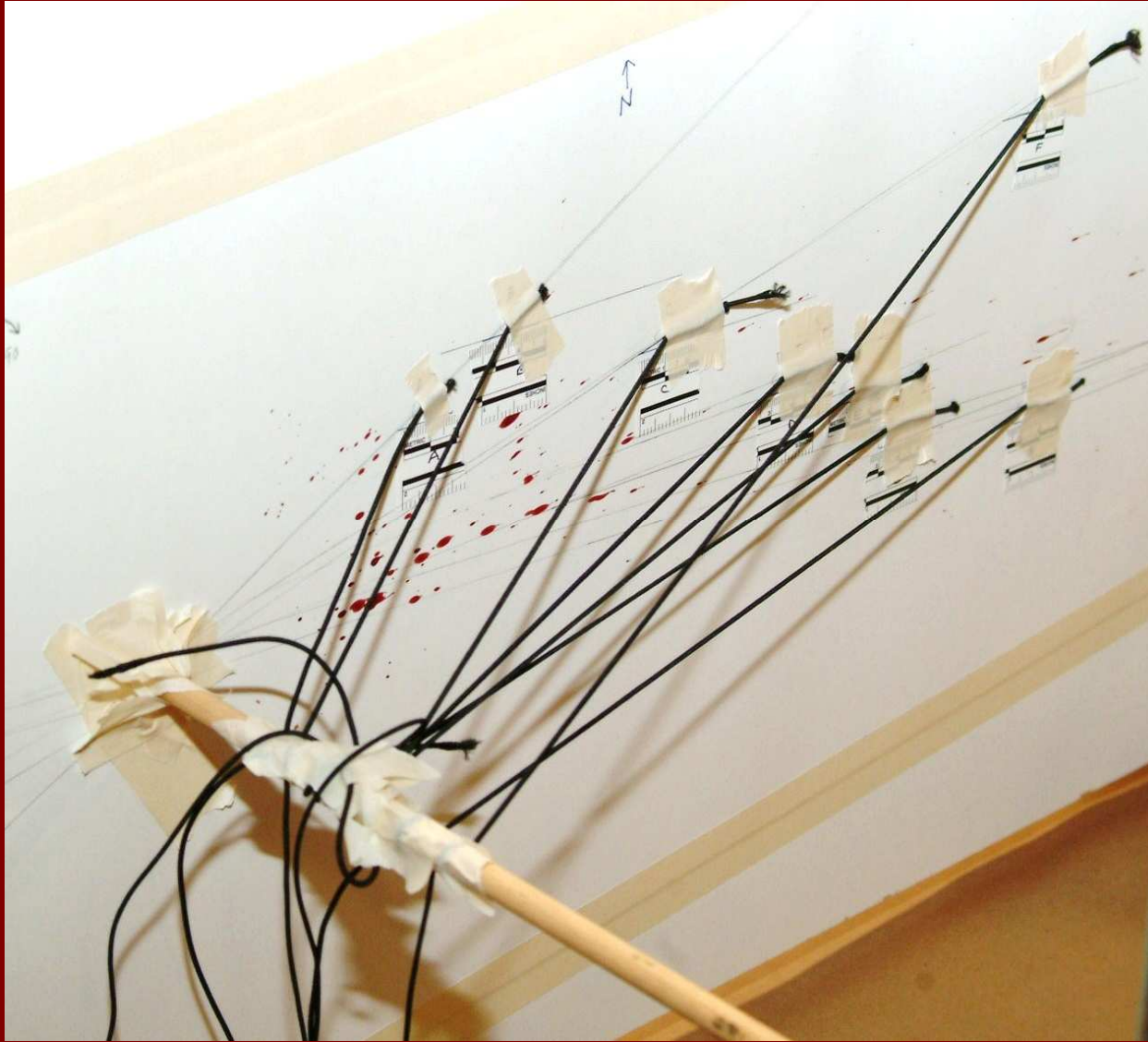
Voids



Wipe



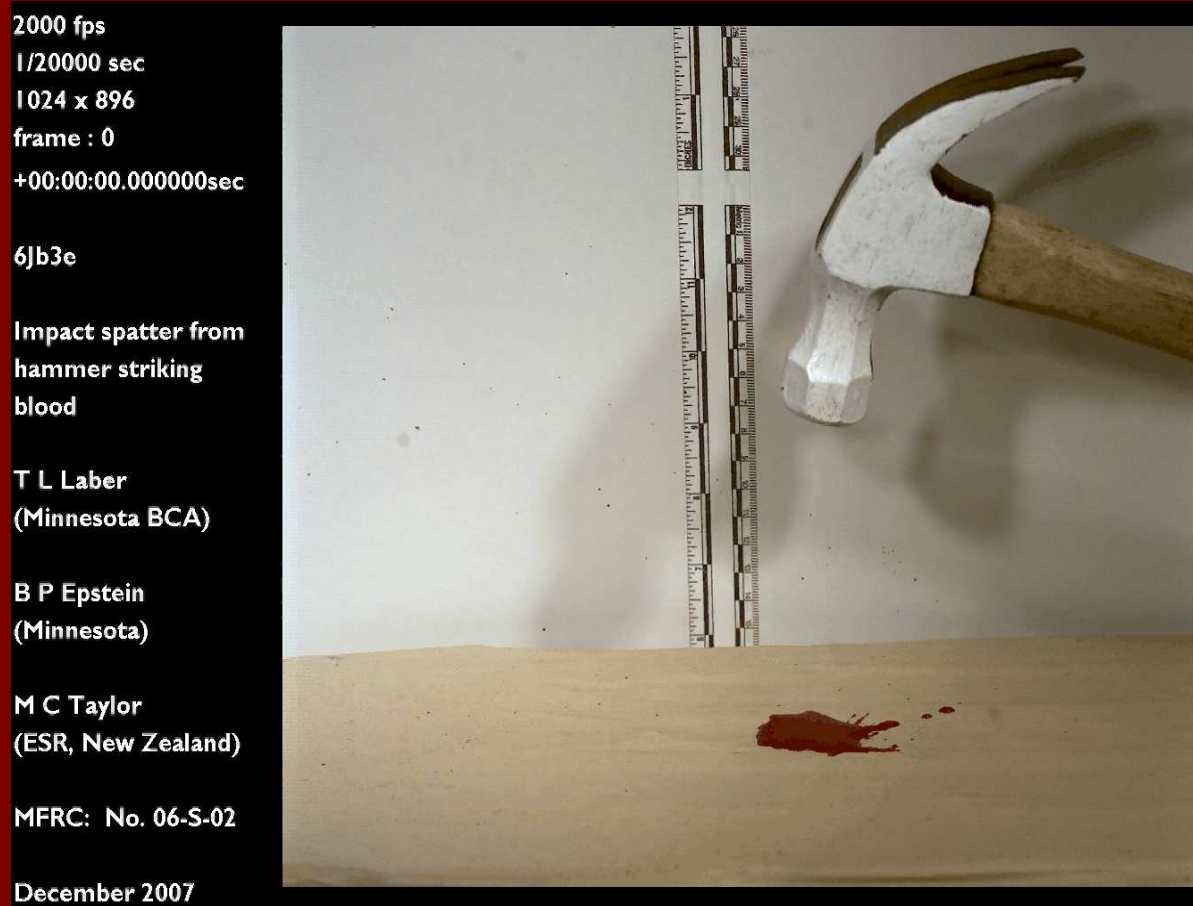
“Stringing” a Bloodstain Pattern



Projectile Motion Activity

Find the Position of the Blood Source

- Blood in flight obeys laws of gravity—a projectile
- Use impact spatter due to blunt force trauma
- Use trigonometry to locate position of source

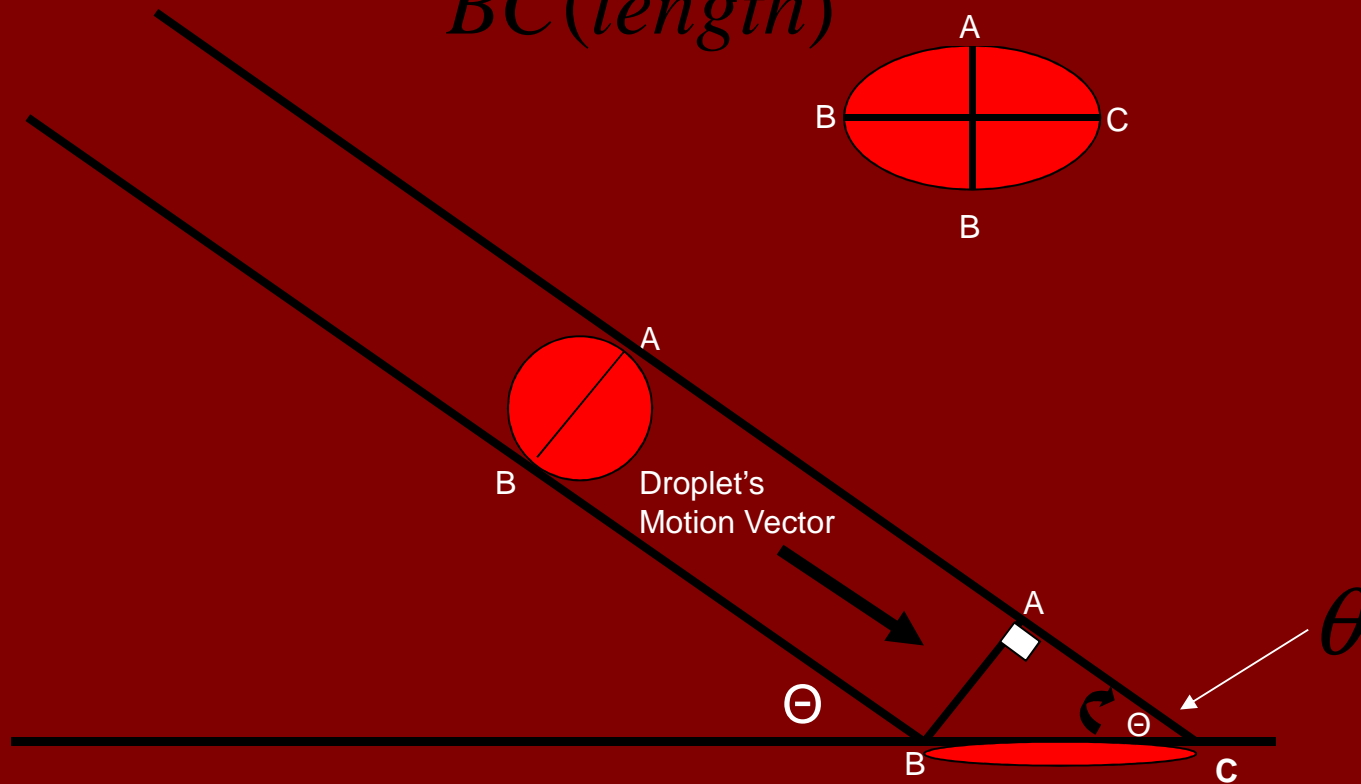


Blood cast onto a surface at an angle has an elliptical shape



Analyzing the Motion of a Blood Droplet

$$\theta = \sin^{-1} \frac{AB(\text{width})}{BC(\text{length})}$$

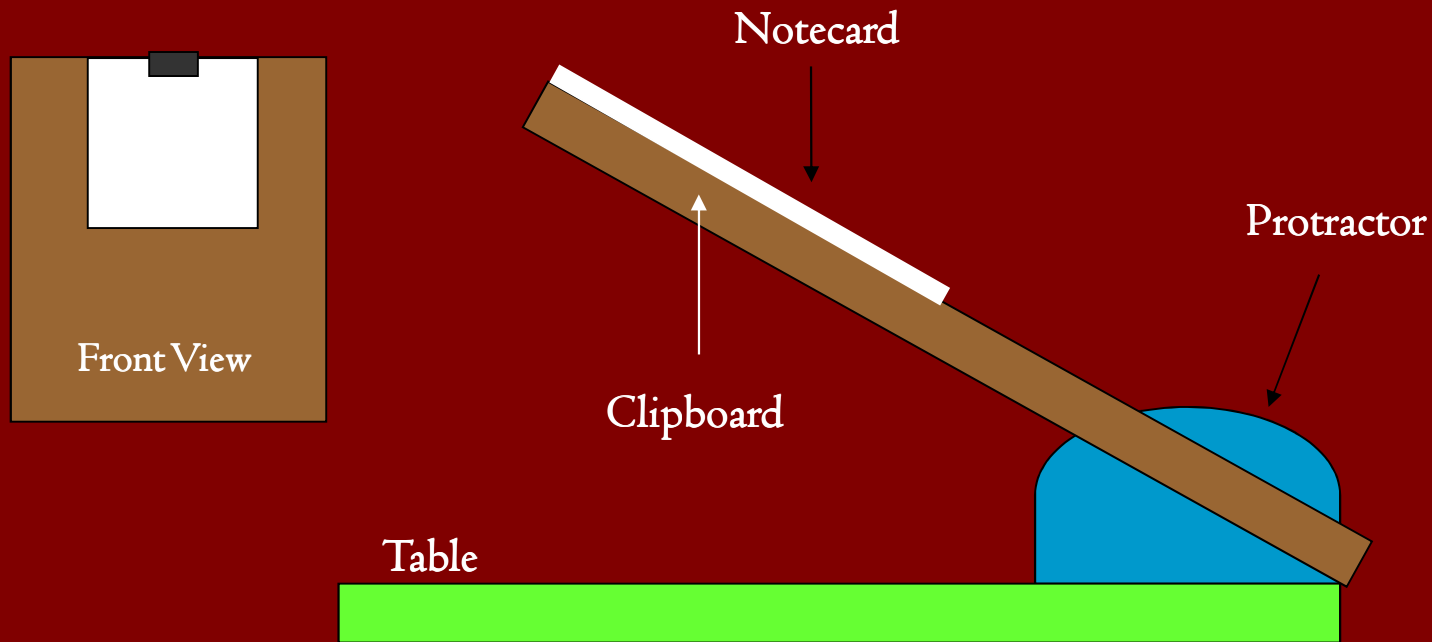


Typical Blood Shapes At Various Impact Angles



Simulating Angled Blood Drops

- Impact Angle Apparatus

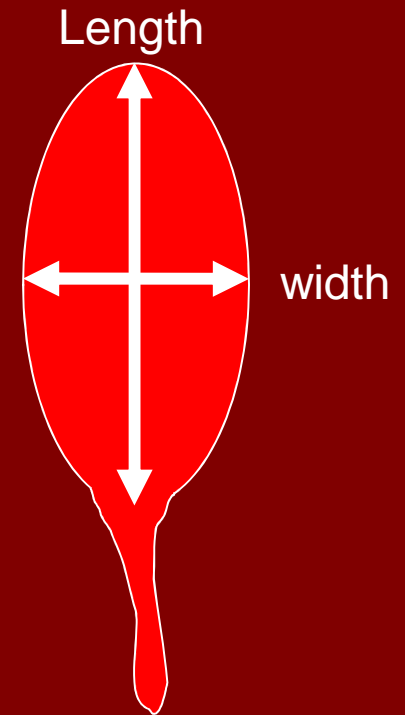
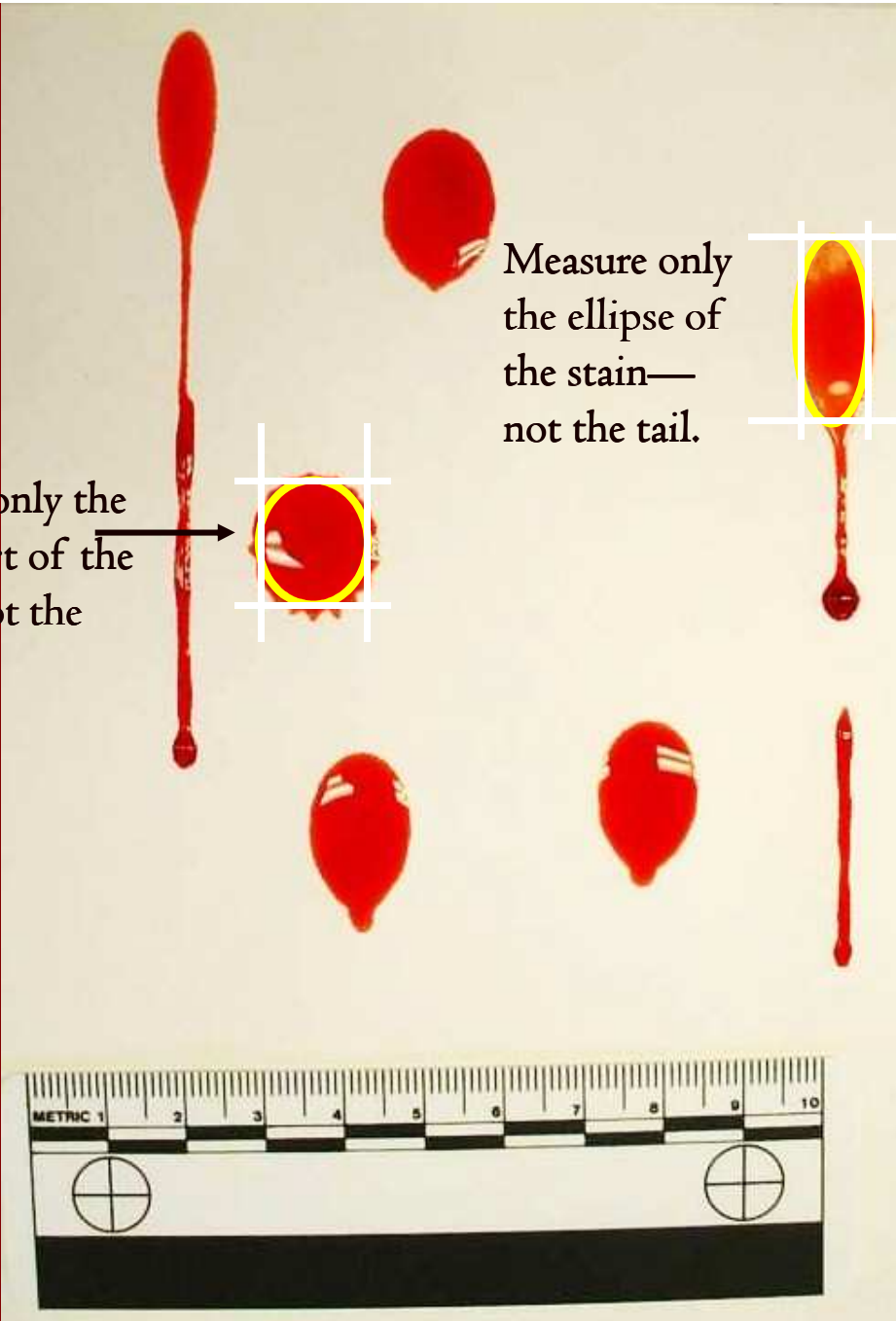


Your Turn 😊

- Use the impact angle clipboard to make sample angled bloodstains
- Remember the impact angle is 90° minus the angle of the clipboard!
- Example for a 30 degree impact angle set your board at $90-30$ or 60 degrees.
- Drip blood at ~30 cm from the board surface
- Count to 10 and let the board return to horizontal
- Try dripping at 30° , 60° and 80°
- Discussion!

Measure only the round part of the stain—not the spines.

Measure only the ellipse of the stain—not the tail.

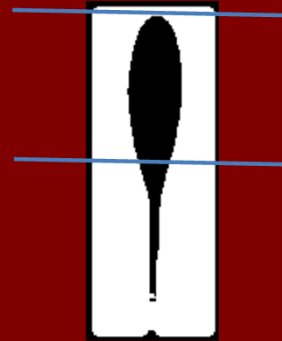
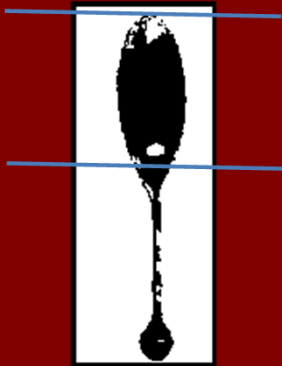


Mathematics of Bloodstains

- Measure width & length of bloodstain to determine impact angle.

Calculating Impact Angles

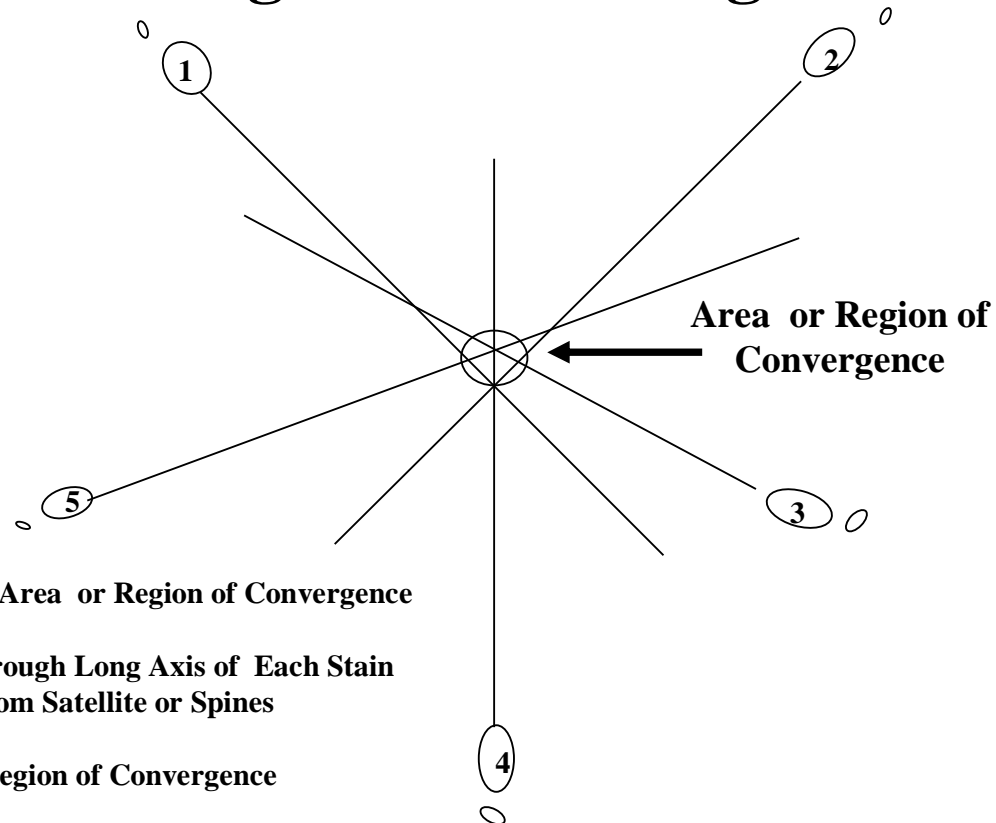
- Impact Angle (θ) = (\sin^{-1}) width/length
- Practice Sheet.



- Blood Drop A: $W/L=0.9\text{cm}/2\text{cm}$ 27°
- Blood Drop B: $W/L=1.2\text{cm}/1.9\text{cm}$ 39°
- Blood Drop C: $W/L=0.7\text{cm}/2\text{cm}$ 20°

Area of Convergence

Area or Region of Convergence



Steps to Determine Area or Region of Convergence

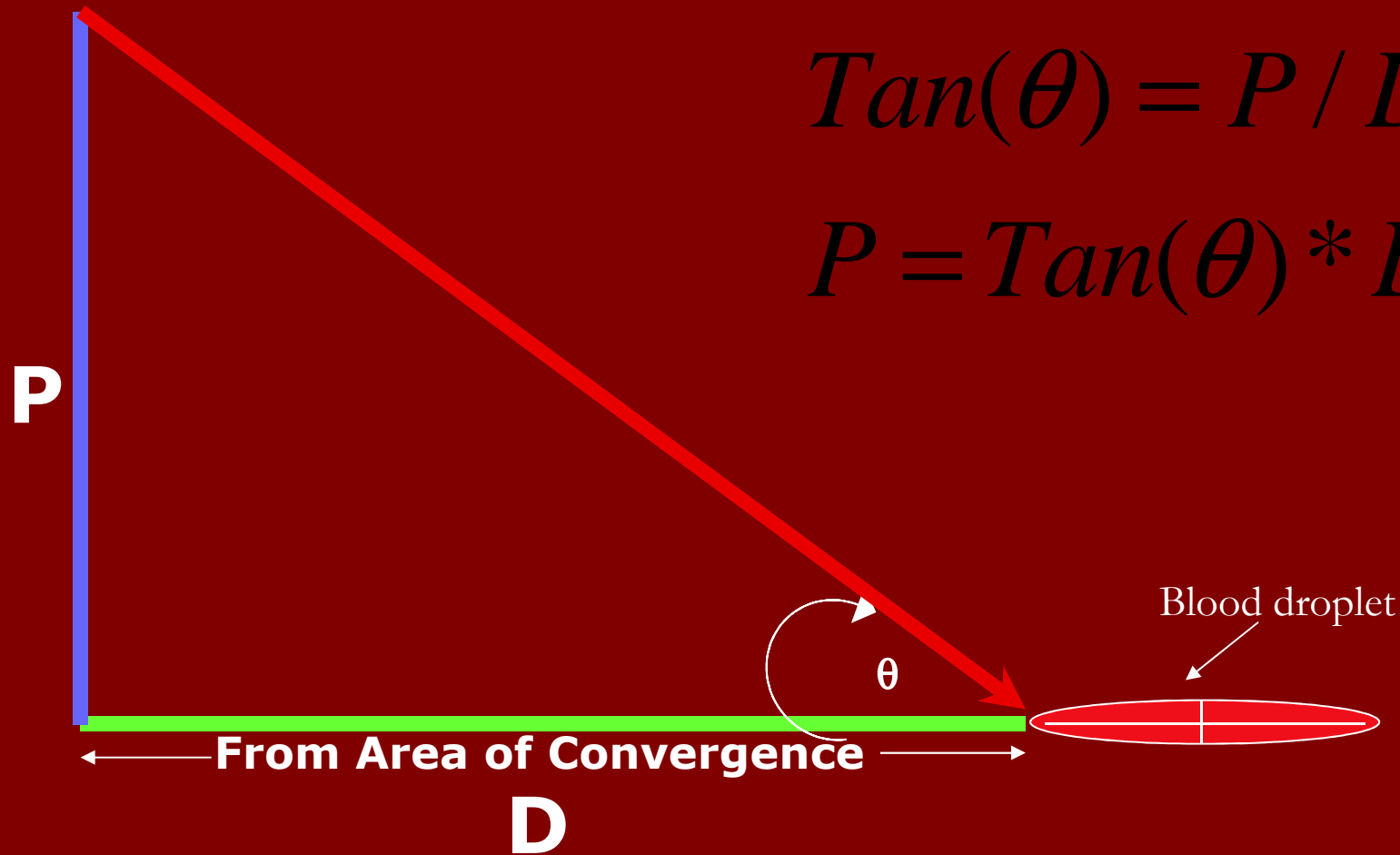
1. Construct Ray Through Long Axis of Each Stain Leading Away From Satellite or Spines
2. Locate Area or Region of Convergence
3. The Center of that Area is Working Point for Origin

FSW 1998

Finding the Third Dimension

$$\text{Tan}(\theta) = P / D$$

$$P = \text{Tan}(\theta) * D$$



Finding the Third Dimension

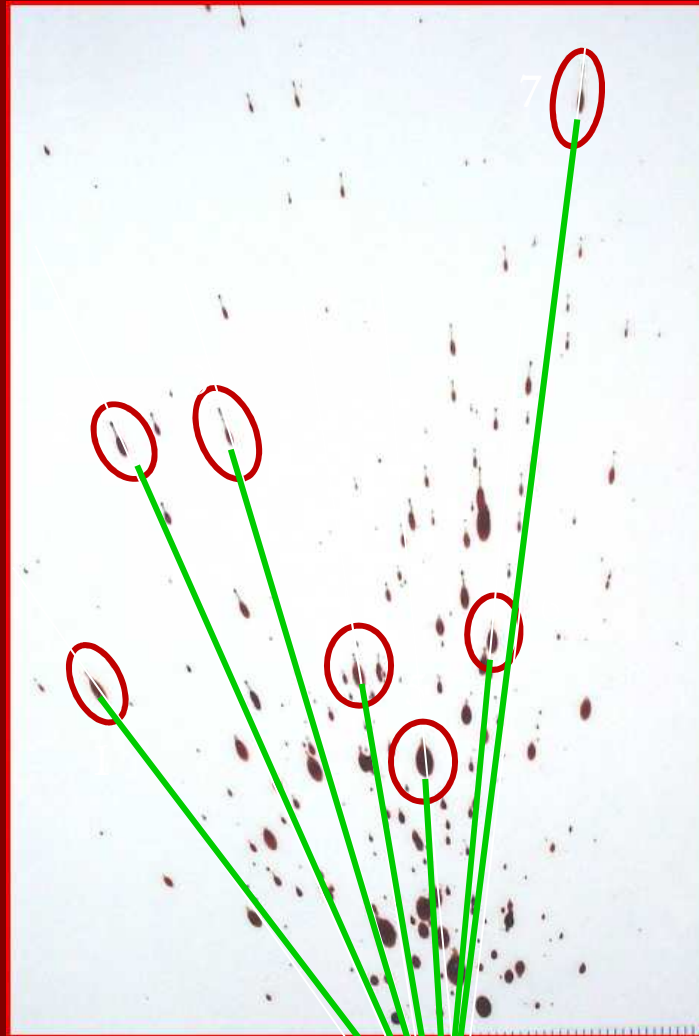
Impact Angles

1. 2/5 24°
2. 1.5/4 22°
3. 1/3 20°
4. 2/4.5 26°
5. 3/6 30°
6. 2/4 30°
7. 1/4 14°

$$\tan \theta = P/D$$

D (point to stain)

1. 11 cm
2. 15 cm
3. 14.5 cm
4. 9.3 cm
5. 7.3 cm
6. 9.7 cm
7. 20.6 cm



$$P = D (\tan \theta)$$

1. 4.9 cm
2. 6.1 cm
3. 5.3 cm
4. 4.5 cm
5. 4.2 cm
6. 5.6 cm
7. 5.1 cm

Conclusion:

The source was 4.2 to 6.1 cm above the Point of Convergence

Point of
Convergence

Supplies for Activities

Blood Spatter Kits from Wards Natural Science

- ✓ Introduction to Blood Spatter Analysis: 36 V 0047
- ✓ Advanced Techniques in Blood Spatter Analysis. 36 V 0048
- ✓ Simulated Drip & Projected Blood. 37 V 5310
- ✓ Simulated Transfer Blood. 37V5311

Thank You—Questions?

- Contact Information: Kathy Mirakovits
www.forensicscience-ed.com
- Forensic Science Workshops Summer 2012
 - Atlanta, GA June 12-15
 - Portland, OR June 26-29
 - LTU (Southfield, MI) July 9-13
 - IUPUI (Indianapolis) July 17-20
 - Portage, MI July 30-Aug 3
- Textbook? www.crcpress.com

