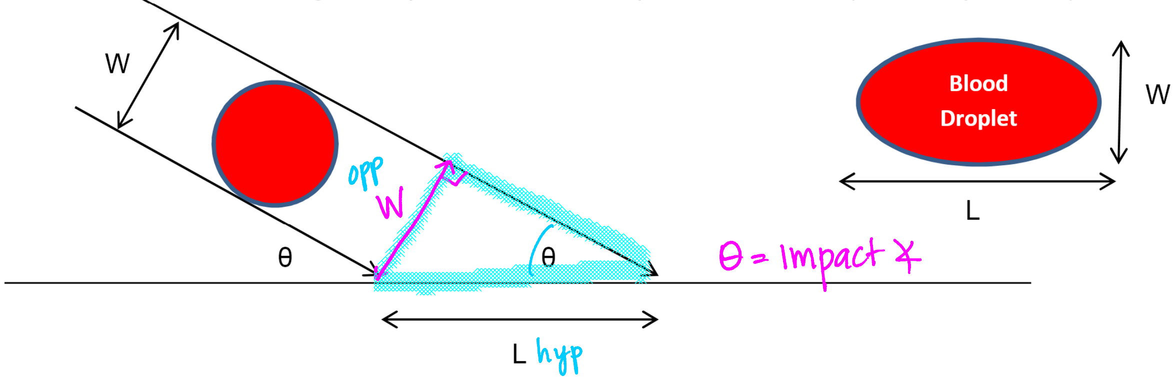
Integrated H
Bloodstain Pattern Analysis

Angular Impact of a Blood Droplet on a Surface (Stationary Source)



Note: Although bloodstains may have other characteristics (spines, cast-off features), the basic shape remains elliptical.

1. Create an equation that relates W, L, and sin θ.

$\sin\theta = \frac{W}{L}$

W = width
L = length
θ = impact ∡

2. A man is in a fight. His injuries have him hovering over the ground and he is not moving. He is then kicked in the face, which creates a bloodstain formation that measures 8 mm in length (L) and 4 mm (W) in width. Find the impact angle of the blood droplet

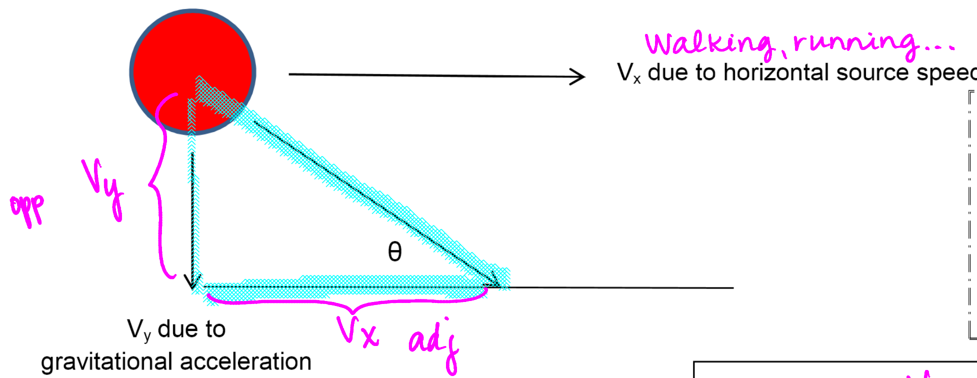
$\sin\theta = \frac{W}{L}$

$\sin\theta = \frac{4}{8}$

$\theta = \sin^{-1}(1/2)$

$\boxed{\theta = 30^\circ}$

Impact on the Ground of a Blood Droplet from a Moving Source



$V_y = \sqrt{2gh}$
g = 9.8
h = height (meters)
*assumes no air resistance (true for large droplets over a relatively short distance

3. Create an equation that relates V_x, V_y, and tan θ.

$\tan\theta = \frac{V_y}{V_x}$ or $\tan\theta = \frac{\sqrt{2gh}}{V_x}$

4a.) Why is the equation in Question (2) useful?

$\sin\theta = \frac{W}{L}$ allows us to calculate the impact ∡

4b.) Why is the equation in Question (3) useful?

$\tan\theta = \frac{V_y}{V_x}$ lets us calculate the speed of the blood source (walking, running, etc.)

5. An assailant walks rapidly away from a crime scene, blood dripping from a wound to his hand. A typical elliptical bloodstain has a length of 7mm and a width of 6mm. Estimate his walking speed assuming that his hand is moving with the same velocity as his body.

height is approx 1m

L = 7
W = 6

1st need impact ∡
$\sin\theta = 6/7$
$\theta = \sin^{-1}(6/7)$
$\theta \approx 59°$

2nd Find V_y
$V_y = \sqrt{2gh}$
$V_y = \sqrt{2(9.8)(1)}$
$V_y \approx 4.43$

3rd Find V_x
$\tan 59 = \frac{4.43}{V_x}$
$V_x \cdot \tan 59 = 4.43$
$V_x = 4.43/\tan 59 \approx$ 2.66 m/s

6. Estimate the ratio of the elliptical stains formed from blood droplets impacting the ground from a wounded suspect, described as tall and running at 4 m/s, assuming they are from a head wound.

height is approx 1.75m

$V_x = 4$ m/s
$h \approx 1.75$m

$\sin\theta = \frac{W}{L}$ $\tan\theta = \frac{V_y}{V_x}$ $V_y = \sqrt{2gh}$

1st $V_y = \sqrt{2(9.8)(1.75)}$
$V_y \approx 5.86$

2nd $\tan\theta = \frac{5.86}{4}$
$\theta \approx 55.68°$

3rd $\sin(55.68) \approx .83$
The ratio is ≈ .83

7. Bloodstains of width 6.5 mm and length 8.0mm are identified from a wounded man, described as running away from a crime scene at 3 m/s. Determine whether you would consider that these arise from a head or hand wound.

$W = 6.5$
$L = 8$
$V_x = 3$

$\sin\theta = \frac{W}{L}$ $\tan\theta = \frac{V_y}{V_x}$ $V_y = \sqrt{2gh}$

1st $\sin\theta = \frac{6.5}{8}$
$\theta \approx 54.34°$

2nd $\tan(54.34) = \frac{V_y}{3}$
$V_y = 3 \cdot \tan(54.34)$
$V_y \approx 4.18$

3rd $4.18 = \sqrt{2(9.8)h}$
$(4.18)^2 = (\sqrt{19.6h})^2$
$17.4724 = 19.6h$
$.89m \approx h$

Most likely a hand wound unless they are hunched over and running!

Teacher Notes:

- Blood droplets in free-fall through the air adopt a spherical shape (surface tension forces act to minimize the surface energy leading to a surface with minimum area).
- On perpendicular impact, the blood spreads out equally in all directions (circular stain).
- If angle is less than 90º, the blood will spread out in all directions, BUT on impact the spherical droplet will intersect the surface in an elongated fashion in the direction of travel. This leads to an elliptical shape of a stain, where the long axis (L) lies in the direction of impact along a surface and the short axis (W) is in the transverse direction.