Firearm Residue

• **Gunshot residue (GSR)** – tiny particles expelled from a firearm when it is fired

• When a firearm is discharged, the bullet, unburned and partially burned particles of gunpowder, and smoke are propelled out the barrel toward the target

• If the muzzle of the weapon is close, these products will be deposited onto the target

• The distribution of gunpowder particles and other residues around a bullet hole allows for an estimation of the distance from which a handgun or rifle was fired
Residue

- When garments are taken to the crime laboratory, the surfaces are examined microscopically for the presence of gunpowder residue.

- The powder-residue pattern on the victim’s clothing or skin is compared to test patterns the suspect weapon makes when fired at varying distances from a target.
Distance Determination: Contact shot

- Holding the gun in contact with and up to 1 inch from the target creates a star-shaped (stellate) tear pattern around the bullet hole entrance, rimmed by a smoke-like deposit of vaporous lead.
Residue

Distance Determination: 6-18 inches

- A halo of vaporous lead (smoke) deposited around a bullet hole normally indicates a discharge of 12 to 18 inches or less.

- Scattered specks of unburned and partially burned powder grains *without* any accompanying soot are often observed at distances up to 25 inches (and occasionally farther).
Residue

Distance Determination: > 3 ft

• More than 3 feet will not usually result in deposits of powder residue
• There may be a **dark ring around the hole**, known as a bullet wipe
Distance Determination: Shotguns

- Distance determinations for shotguns are also made by comparing crime scene evidence to test fire patterns. Generally, the more spread out the shot, the farther the distance of the shooter.

Generally, the spread increases 1 inch for each yard of distance (based on 12 gauge shotgun)
Residue

Revealing Powder Residues

• Infrared photography can enhance the contrast of vaporous lead and powder particles around a bullet hole.

• The **Griess test** can detect invisible gunpowder residues.

• Chemically treated, gelatin coated paper is ironed onto the target

• Nitrite particles from gunpowder are revealed by the chemical reaction
Residue

Primer Residue on Hands

- Firing a weapon also propels residues back toward the shooter

- Traces of these residues are often deposited on the shooter’s firing hand, and detection can determine whether an individual has recently fired a weapon

- Examiners measure the amount of barium and antimony on the suspect’s hands, particularly the thumb web, the back of the hand, and the palm
Gun Powder Residue around Wounds
Trajectory

- **Trajectory** is the path of the propelled bullet.

- From the angle of trajectory, investigators can trace the path back to the shooter
  - For example: if a trajectory angle is downward, the position of the shooter was above his or her target.

- Ignoring gravity, a straight line can be drawn between two reference points such as:
  - Holes in windows and walls
  - Entrance and exit wounds on a victim
Gravity and Trajectory

Two forces are acting on a fired bullet:
- forward force of the gunshot
- downward force of gravity

In a long distance shot, the line of sight to the target must be adjusted to compensate for the effect of gravity.

Wind speed and direction can also affect this adjustment.
Trajectory

Locating the Shooter (Example)

• A bullet is found in a vehicle
• The bullet penetrated the front driver’s side window and then the seat
  • These 2 holes will be reference points
• The bullet may have come from a building across the street
• Using a laser beam, they project a line creating the approximate trajectory path of the bullet from the building to the car
Locating the Shooter: Similar Triangles Method/Distance Vs. Drop

- To determine the distance between the shooter and the hole in the car seat, investigators must set up a direct proportion using the two right angles.
**Trajectory**

**Calculation: Distance vs. Drop**

Distance to the window \((A)\) = Distance to the shooter \((C)\)

Distance along horizon \((B)\) = Distance to the building \((D)\)

We can figure out the distance to the shooter by taking the other measurements and solving for \(C\). *This assumes you have a general idea of where the shooter was!*
**Trajectory**

Calculation: Distance vs. Drop

\[
\frac{\text{Distance to the window (A)}}{\text{Distance along horizon (B)}} = \frac{\text{Distance to the shooter (C)}}{\text{Distance to the building (D)}}
\]

\[
\frac{23.9}{23.5} = \frac{C}{720}
\]

Cross multiply:

\[
(23.9)(720) = (23.5)C
\]

\[
C = 732.3 \text{ in}
\]
Now we have 2 sides of the triangle (the hypotenuse and adjacent side), we can use the Pythagorean Theorem to figure out the opposite side (the height of the shooter from the horizon).

\[ a^2 + b^2 = c^2 \]

\[ 720^2 + b^2 = 732.3^2 \]

\[ b = 133 \text{ inches (~11ft)} \]

The shooter was 133 inches from the horizon (not necessarily the ground).
Another Way… Law of Tangent

- Use your 2 reference points to set up a right triangle
- When you find the angle (using a protractor or MATH!)
- Use Law of Tangents to solve for the height of the opposite side of the right triangle.

Trajectory
Another Way… Law of Tangent

• Remember SOH CAH TOA
• Measure the distance along the horizon from your bullet hole to the side of the building

\[ \tan \theta = \frac{\text{opposite side (height)}}{\text{adjacent side (distance to building)}} \]
Another Way... Law of Tangent

\[
\tan (10.5) = \frac{\text{opposite}}{720}
\]

\[
\tan (10.5) \times 720 = \text{opposite} = 133 \text{ inches (~ 11 ft)}
\]
Trajectory

Calculation (Distance vs. Drop)

• With this information the investigator can determine where the shooter was, and at what height (or floor) the bullet originated
Tool Marks and Other Impressions

Tool Marks

A tool mark is any impression, cut, gouge, or abrasion caused by a tool coming into contact with another object

- **Abrasion mark** – a mark produced when a surface slides across another surface
- **Cutting mark** – a mark produced along the edge as a surface is cut
- **Indentation mark** – a mark or impression made by a tool on a softer surface
Tool Marks and Other Impressions

Tool Marks

• A careful examination of the impression can reveal important class characteristics, such as the size and shape of the tool.

• It is the presence of minute imperfections on a tool that individual characteristics.

• The shape and pattern of such imperfections are further modified by damage and wear during the life of the tool.
Tool Marks and Other Impressions

Collecting Tool Mark Evidence

• When practical, the entire object or the part of the object bearing the tool mark should be taken to the crime lab.
  • Maintain chain of custody

• **Under no circumstances should the crime scene investigator attempt to fit the suspect tool into the tool mark!**
  • Any contact between the tool and the marked surface may alter the mark
  • This action will at least raise serious questions about the integrity of the evidence
Tool Marks and Other Impressions

Collecting Tool Mark and Impression Evidence

- Before any impression is handled, it must be photographed (including scale).

- If the impression is on an easy to move item, such as glass, paper, or floor tile, the evidence is transported intact to the laboratory.

- If the surface cannot be submitted to the laboratory, the investigator may be able to preserve the impression:
  - Example: lifting a fingerprint
  - Example: making a cast of a shoe or tire impression
  - Example: chemical enhancement of latent bloody shoe impressions
Points of Comparison

- The comparison microscope is used to compare crime scene tool marks with test impressions made with the suspect tool.
- A sufficient number of points of comparison, or the uniqueness of such points, will support a finding that:
  - both the questioned and test impressions originated from the same source, OR
  - The suspect tool could NOT have made the mark.
- New computer software and websites may be able to assist in making shoeprint and tire impression comparisons.
- Also, bite mark impressions on skin and foodstuffs have proven to be important evidence in a number of homicide and rape cases.