



# Introduction

Ballistic evidence helps explain:

- What type of firearm was used
- The caliber of the bullet
- The number of bullets fired
- Where the shooter was located
- Whether a weapon was fired recently
- If a firearm was used in previous crimes



# Vocabulary

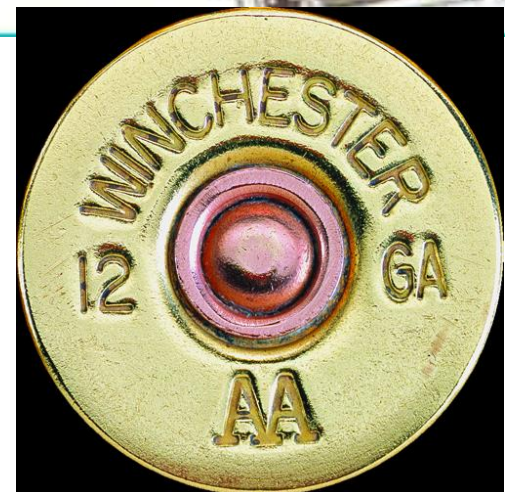
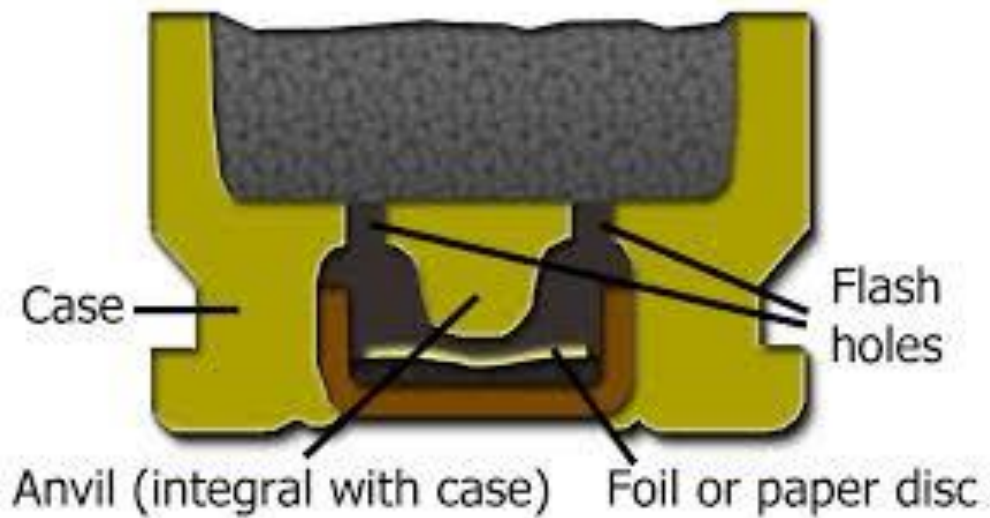
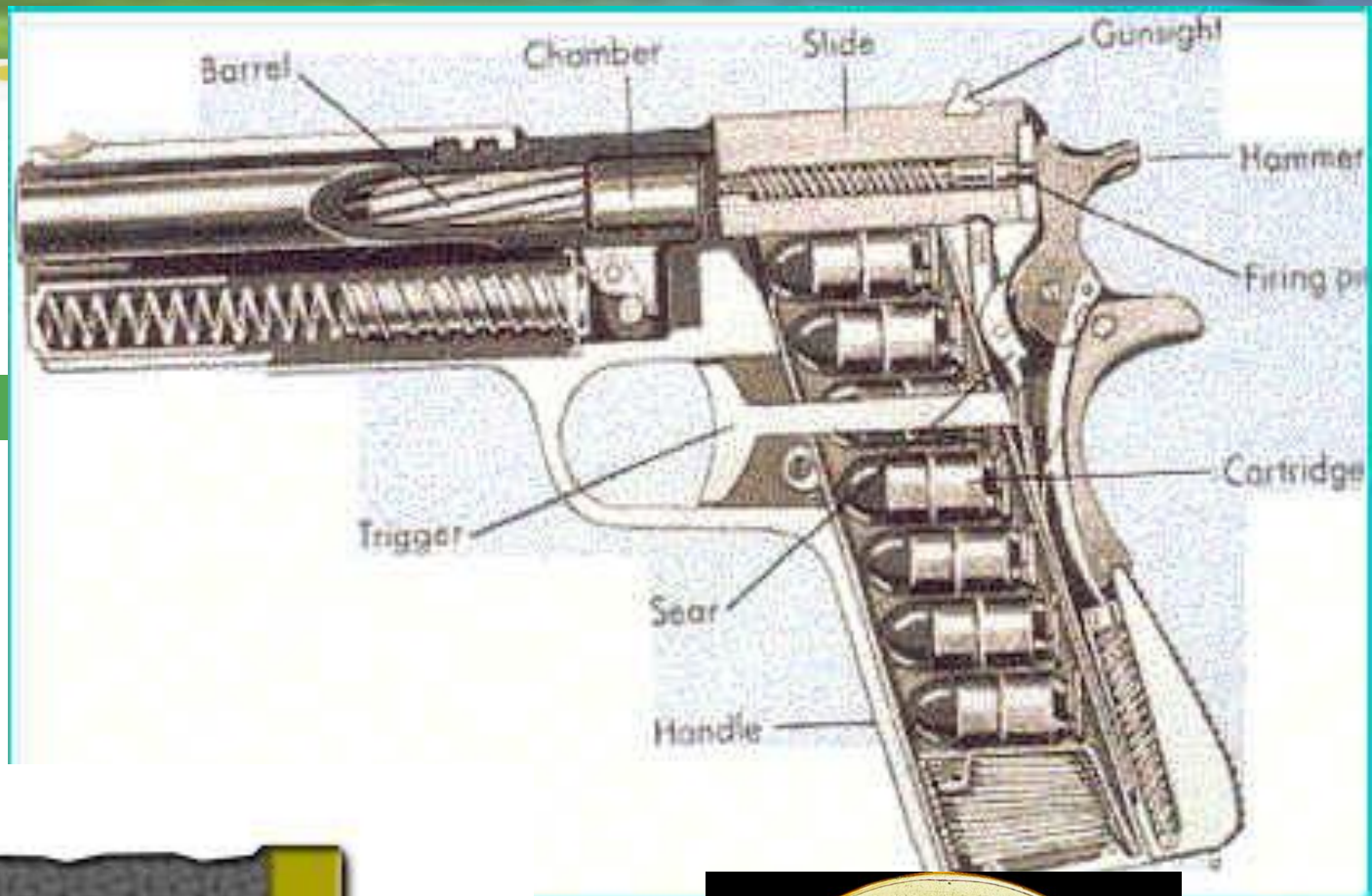
- **Ballistics** is the study of bullets and firearms.
- A **firearm** is a weapon, such as a gun, capable of firing a projectile using a confined explosive.
- **Gunpowder** is potassium nitrate, charcoal, and sulfur. When ignited, it expands to 6 times its original size, causing a violent explosion.



- **Bullet** – pointed projectile composed of lead, copper, or combination of various metals. Can be metal-jacketed, hollow-pointed, or even plastic coated.
- **Primer power** – mixture initiates the contained explosion that pushes the bullet down the barrel. Struck by firing pin.
- **Firing pin** – strikes the cartridge casing and leaves an impression.



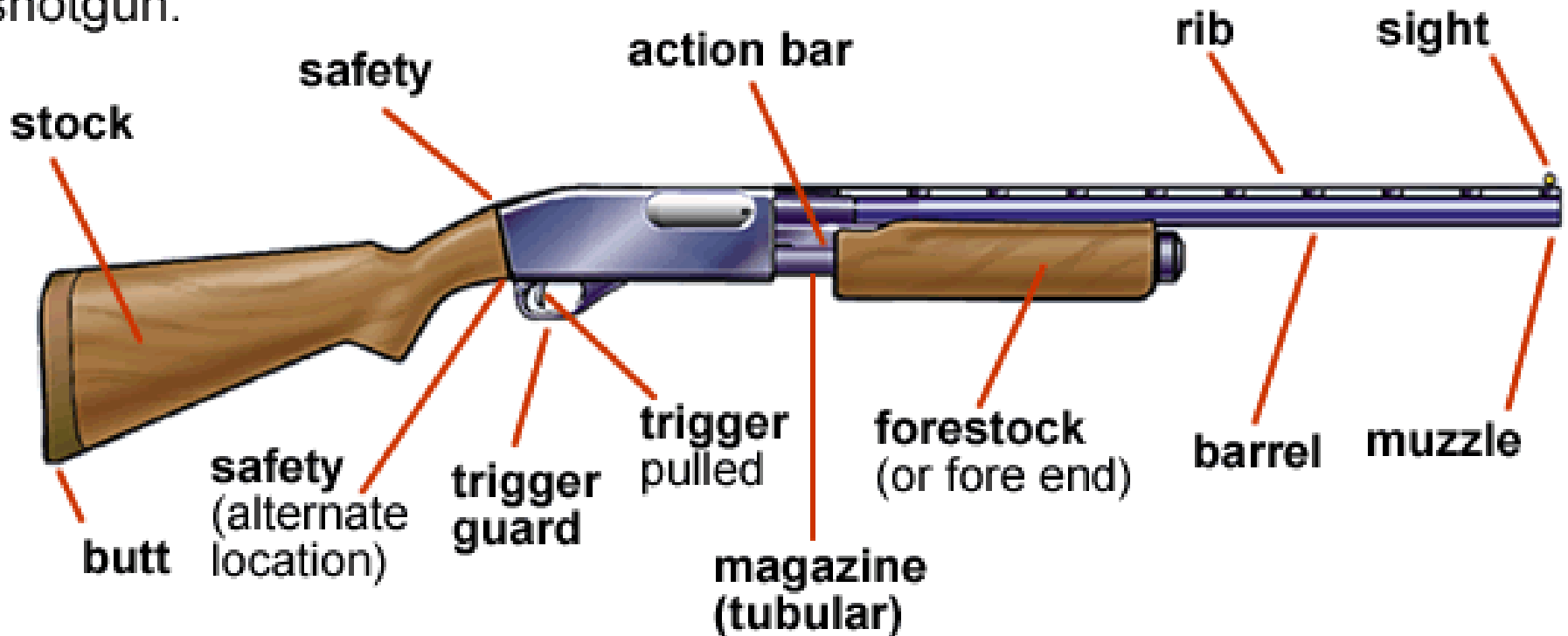
- **Anvil and flash hole** – provide the mechanism of delivery the explosive charge from the primer power to the gunpowder.
- **Headstamp** – on bottom of cartridge casing identifies the caliber and manufacturer of bullet.

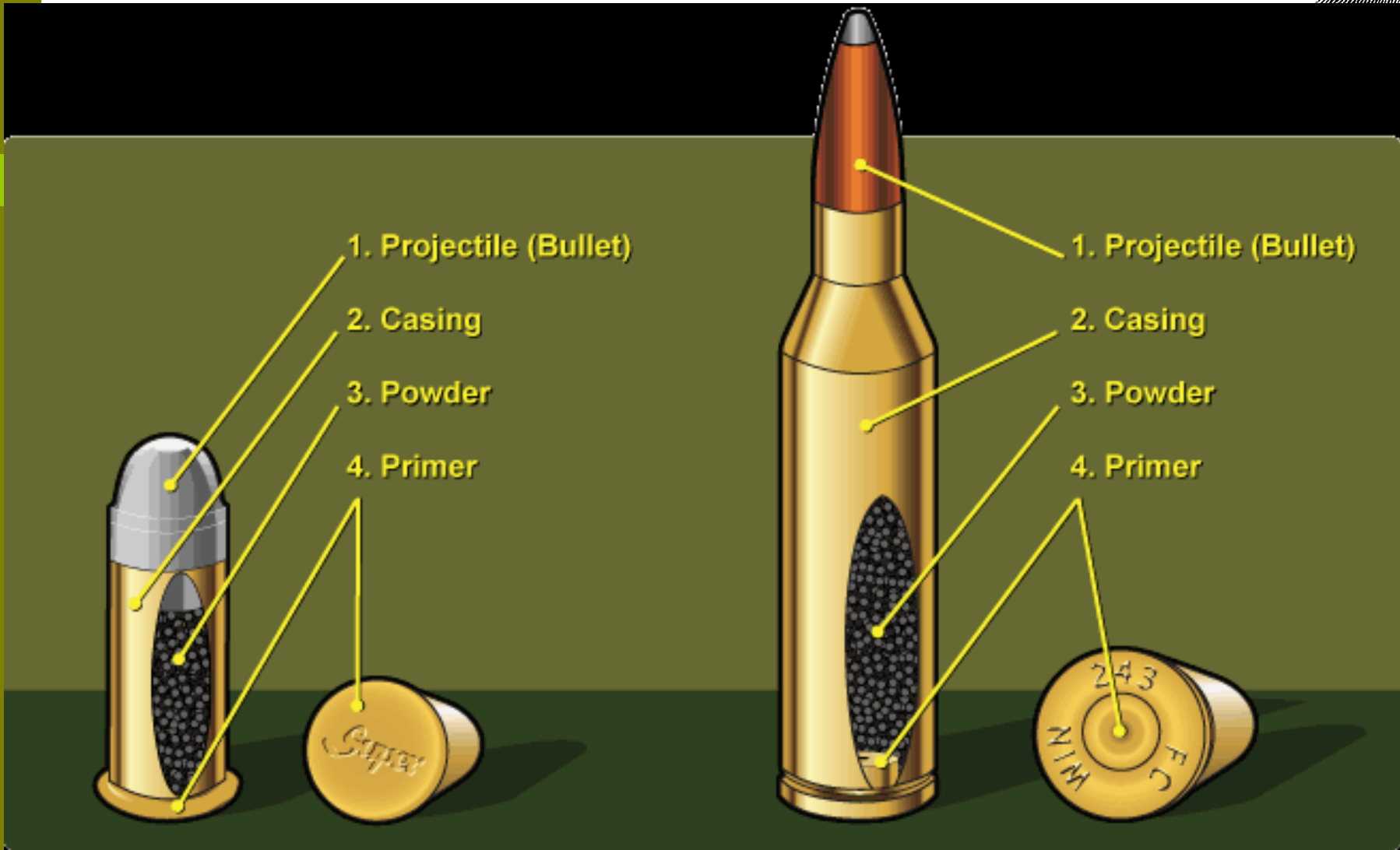




## Parts of a Pump-Action Shotgun

Shotguns are another long-barreled firearm used by hunters. Below are the parts of a commonly used shotgun—the pump-action shotgun.

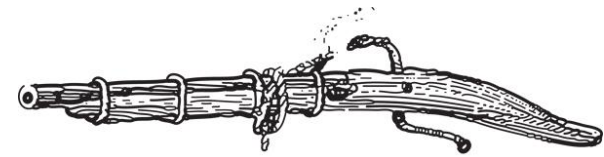




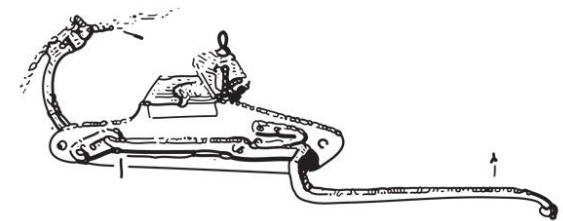
# History of Gunpowder and Firearms



- Chinese invented gunpowder over a thousand years ago (potassium nitrate, charcoal, and sulfur).
- Muzzle-loading matchlocks used wicks to ignite the gunpowder
- Muzzle-loading – gunpowder and projectile loaded down the firearm's barrel (muzzle)
- Flintlock weapons, which used sparks from a chip of flint instead of wicks to ignite gun power. Can be used in damp weather.



Very old matchlock gun



The inside of a matchlock



# History continued



- Percussion firing Cartridge and breech loading
- Cartridge – case that holds a bullet
- The **Percussion rifle** was a type of rifle (or musket ) that utilized the percussion lock (or caplock) mechanism to fire a bullet or musket ball. The Percussion lock mechanism was an evolution of the Flintlock mechanism used on earlier muskets and rifles, with the **Percussion rifle** being introduced from around 1820.



- Breech - opposite end of barrel
- A breech-loading weapon is a firearm in which the cartridge or shell is inserted or loaded into a chamber integral to the rear portion of a barrel.
- Revolver, semi-automatic, and automatic handguns



# Modern firearms divided into Long Guns and Handguns

- Long guns (require use of two hands for accuracy)
  - Rifles fire bullets
  - Shotguns fire pellets (shot) or a single projectile (slug)
- Handguns
  - Pistols are fired with one hand
  - Revolvers have a cylinder that holds usually six cartridges and fire in rapid succession.
- Fully Automatic and Semi-automatic holds 10 cartridges, but fires only one bullet per pull of trigger.



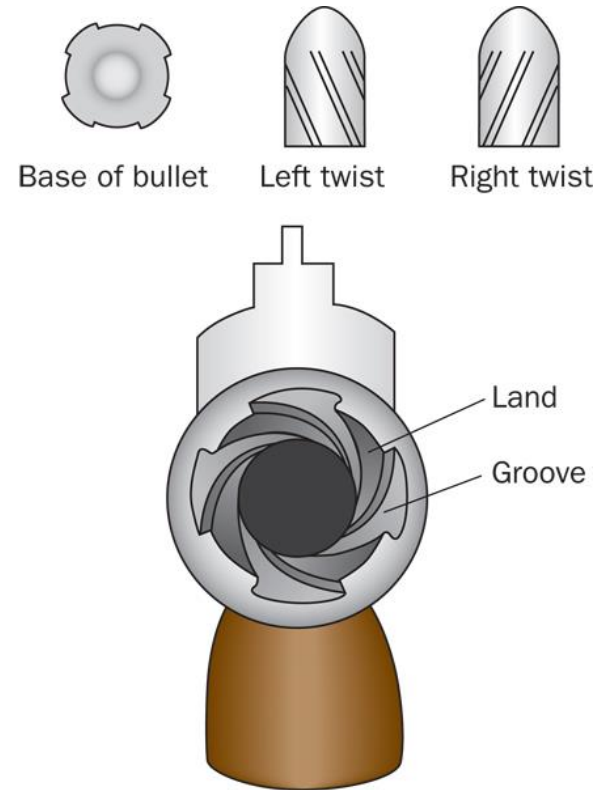
- Automatic fires repeatedly as long as the trigger is pressed.
- Semi-automatic holds 10 cartridges called a magazine or clip, but fires only one bullet per pull of trigger.
- Both the empty cartridge ejects and the next cartridge advances automatically.

# Firearms and Rifling

Word Rifle originally referred to the grooves in indentations in the rifle's barrel.



- Grooves and ridges (*lands*) in the barrel of a gun produce the twisting that adds accuracy
- This leaves a rifling pattern on the bullet that is unique for each gun.
- Therefore, a bullet can be matched to the specific gun from which it was fired

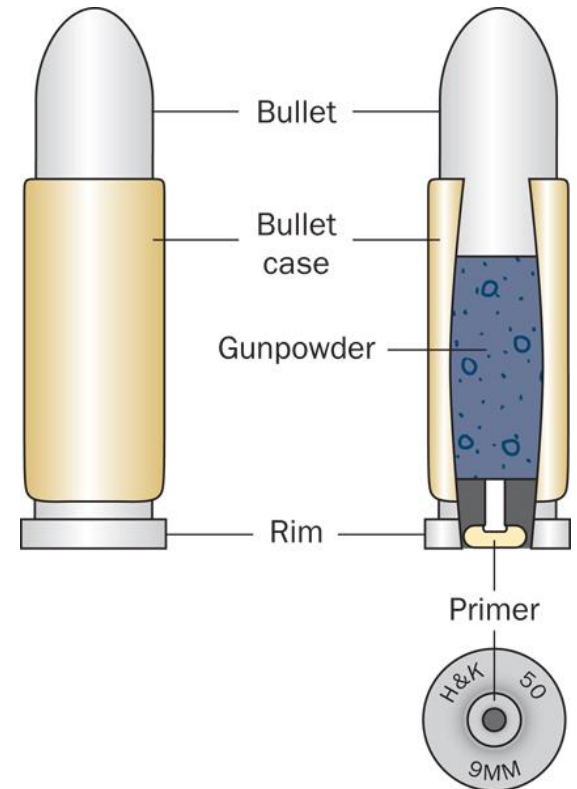


# Bullets, Cartridges, and Calibers

A significant part of ballistics involves examining used bullets and their spent cartridge casing for telltale markings left on them by the firearm that shot them.



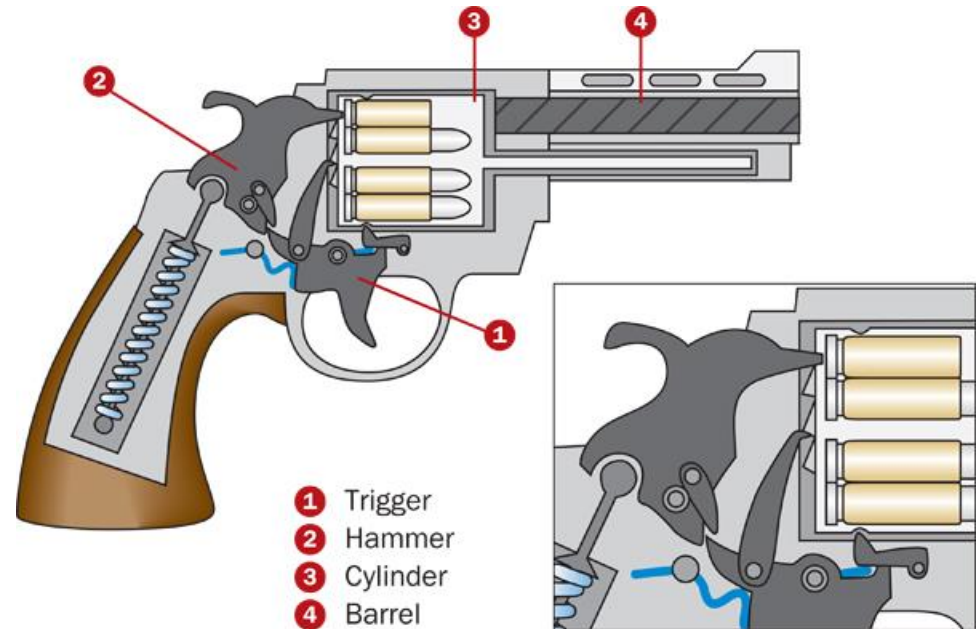
- **Cartridge**—a case that holds a bullet, primer powder, and gunpowder
- The **bullet**, usually of metal, is out front with the cartridge, holding the primer and propellant powders, behind.
- Bullets are named by their caliber and length,
- Sometimes a cartridge is incorrectly referred to as a bullet





# How a Firearm Works

1. The firing pin hits the base of the cartridge, igniting the primer powder

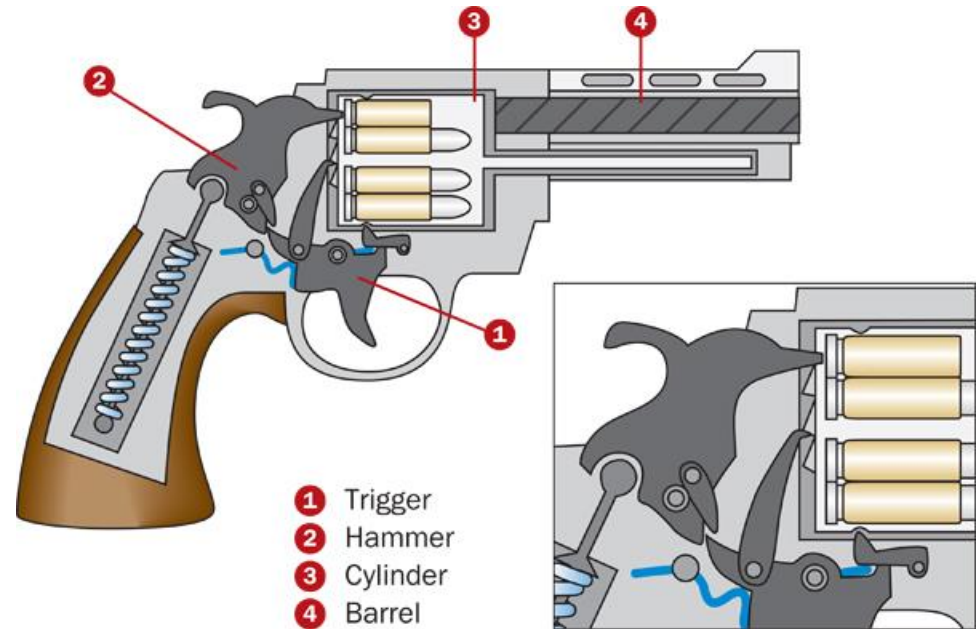


2. The primer powder sparks through the flash hole to the main propellant supply



# How a Firearm Works

3. The pressure of the explosion pushes the bullet from the casing into the barrel



4. The bullet follows the lands and grooves spiraling out of the barrel





# Caliber of the Cartridge

- **Caliber**—a measure of the diameter of the cartridge
- In hundredths of an inch
- Common calibers include .22, .25, .357, .38, .44, and .45
- Why should the caliber of ammunition match the firearm that shoots it? If they do not match, what could go wrong?

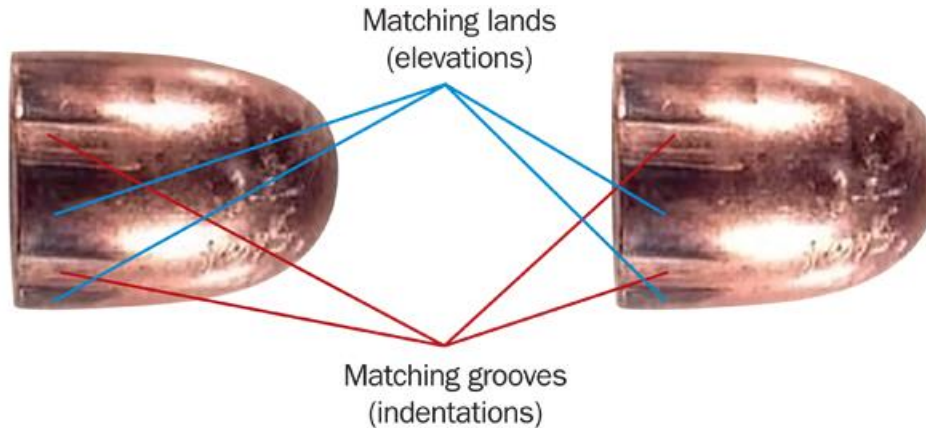


# Naming of Bullets and Cartridges

- o Bullets and cartridges are named basis the diameter of the bullet and the length of the cartridge from base to case rim.



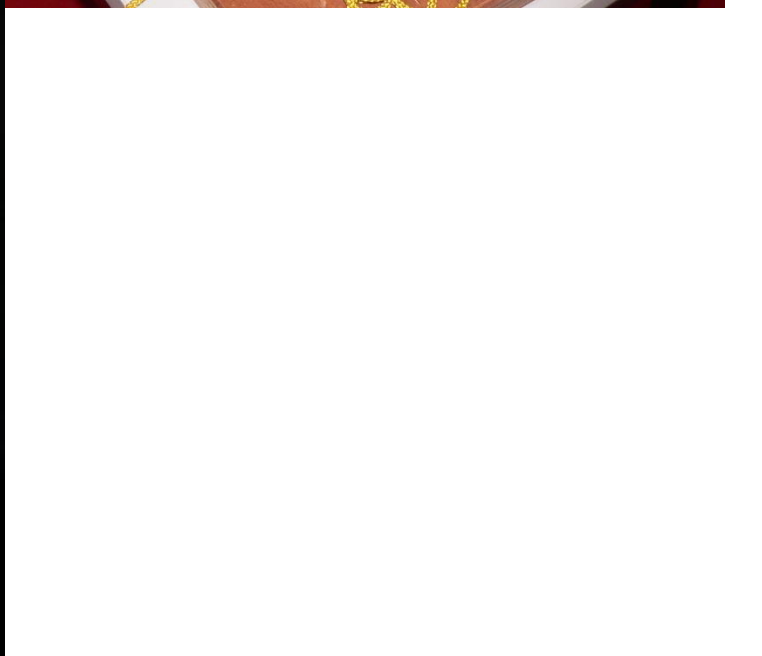
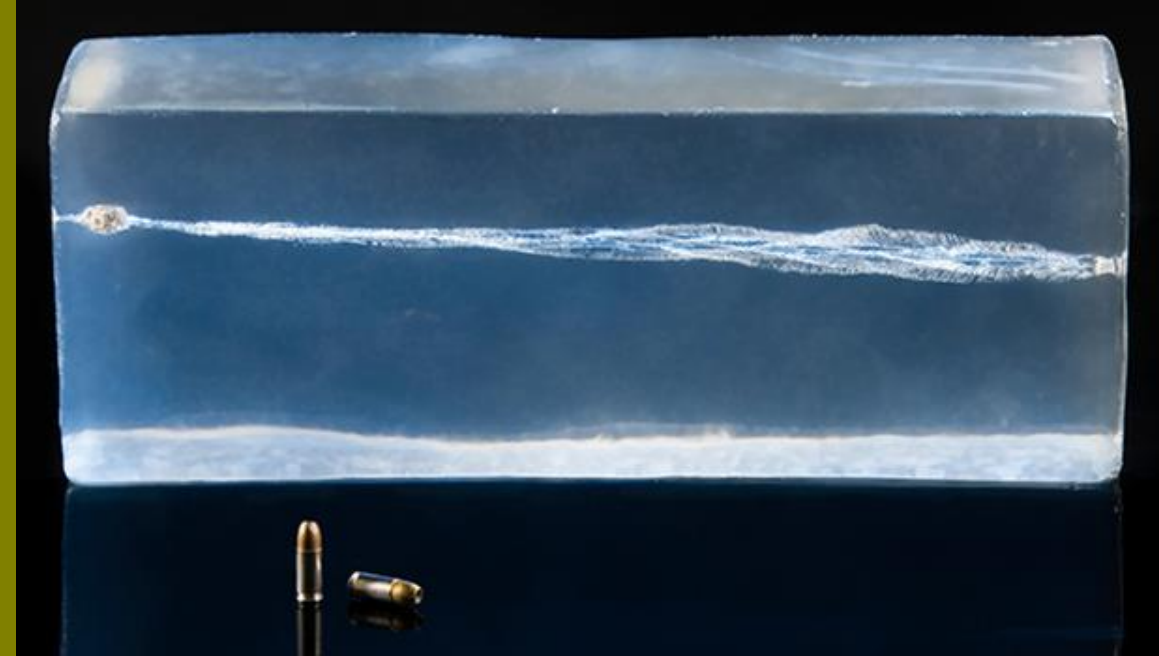
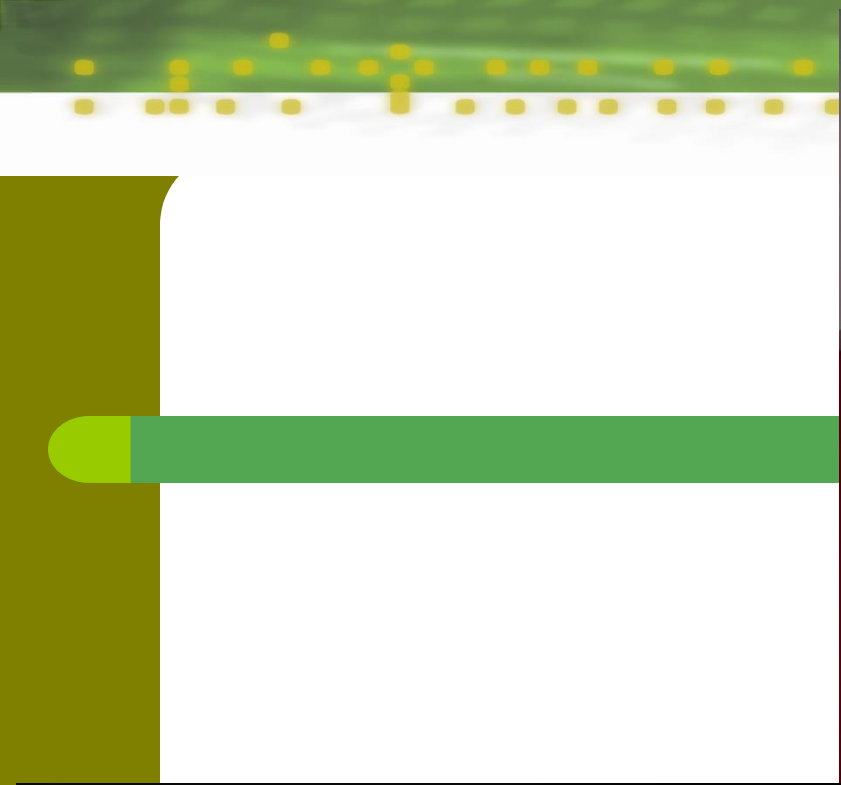
# The Study of Bullets and Cartridge Casings



1. As a gun is fired, the barrel marks each bullet with its own unique pattern of lands and grooves.
2. Investigators match bullet to the gun it was fired.
3. Spent cartridge casings from crime scene with bullets and spent cartridges shot from suspected firearms are compared.



- To get a known bullet for comparison, investigators test-fire the weapon into a water tank or gel block. This captures the bullet without damaging it. Then they can compare the markings on known bullets with those on the suspect bullets.



# Marks on the Spent Cartridge Casings



- Firing pin marks
  - appear on the bottom rim or center of the spent cartridge
  - can be used to match a cartridge to a firearm
- Breechblock marks
  - produced when the cartridge casing slams backward and strikes the breechblock
- Extractor marks minute scratches produced as the cartridge is placed in firing chamber.
- Ejector marks when cartridge is removed from chamber.



# National Data Bases

- o Search all registered firearms.



# Gunshot Residues

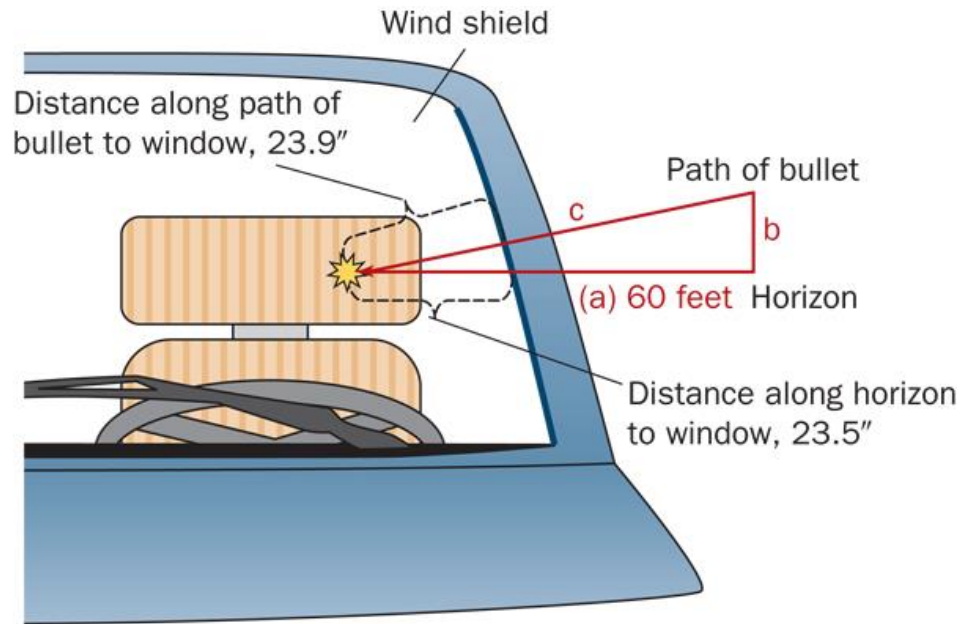
- Gunshot Residues (GSR)
  - Particles of unburned powder (nitrates) and traces of smoke
  - Leave traces on the hand, arm, face, hair, or clothing of the shooter and/or victim
- Chemical testing can detect residue even if removal is attempted
- Distance from victim to shooter can be determined by examining the residue pattern on the victim. GSR decreases as distance between firearm and victim increases.





# Trajectory – path of the propelled bullet.

- o Two reference points are needed to define the trajectory
- o Investigators can figure the shooter discharged the firearm somewhere along that line





# Trajectory

- Reference points can be
  - bullet holes in objects or victims
  - An entry point and exit point on a victim
  - Gunshot residue or spent cartridge casings
- Lasers can trace a straight-line path to determine the position of the shooter



# Trajectory and Gravity

- Bullet's path is slightly curved
- Gravity pulls it downward as the bullet moves forward

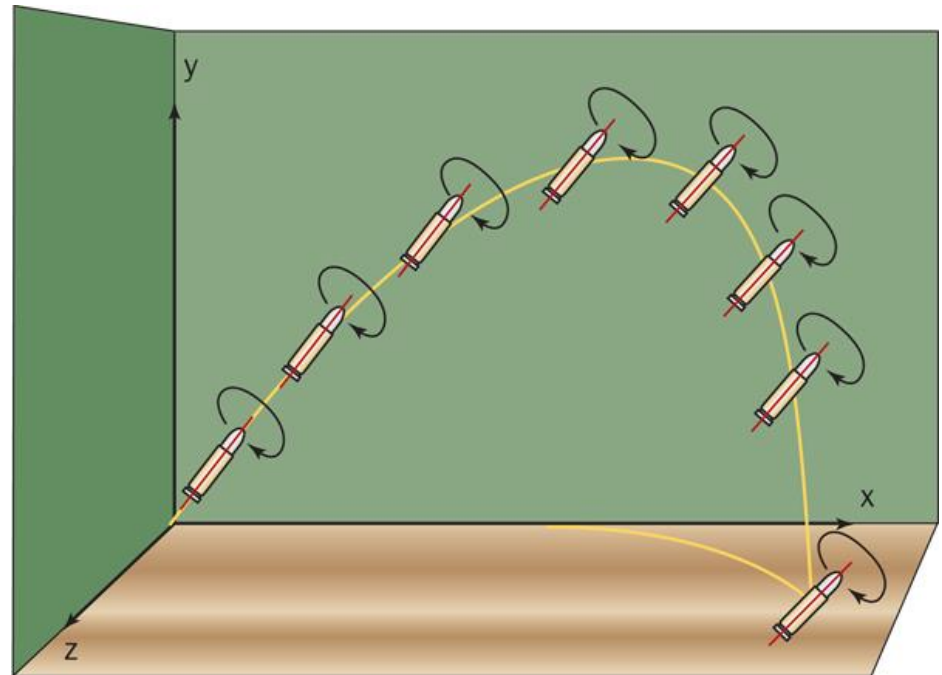


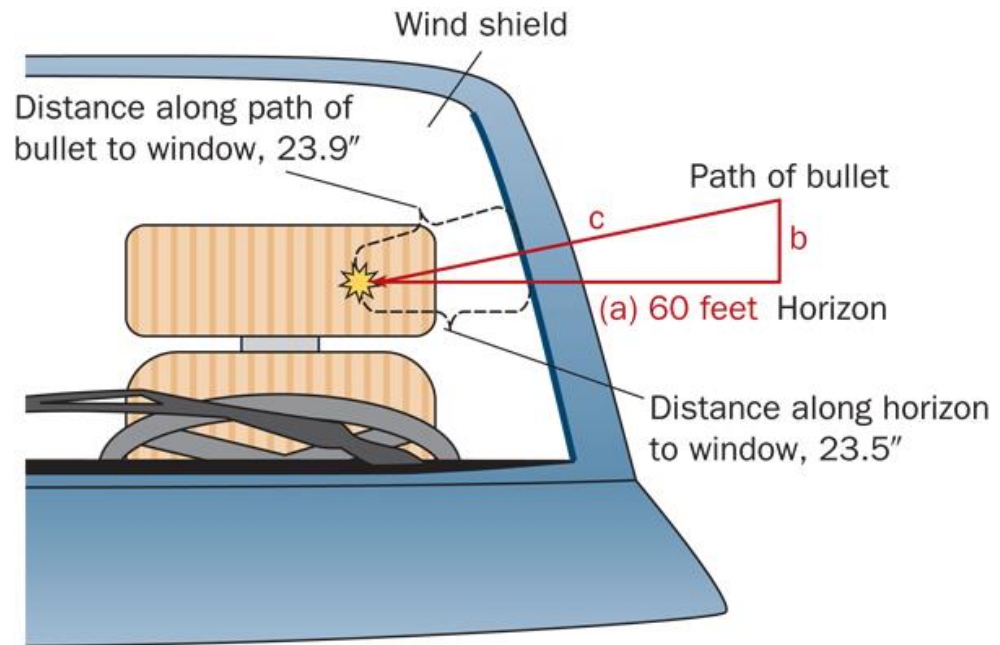
Diagram is highly exaggerated



# Determining the Location of the Shooter

Building is 60 feet away along the horizon line  
Bullet hole is 4 feet above the ground

Where is the shooter located?



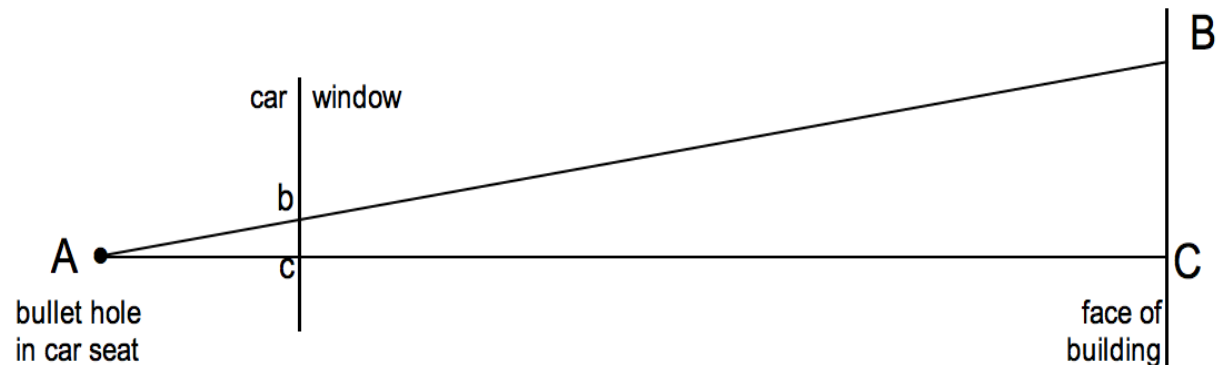


# Triangulation

- o B is where the shooter is located; find the length of BC
- o The  $Abc$  triangle has the same proportions as the  $ABC$  triangle

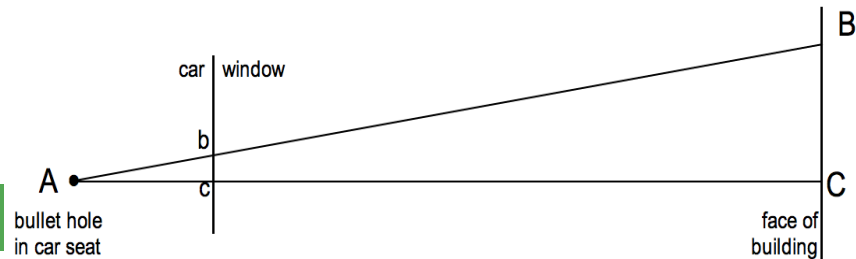
- o So  $\frac{Ab}{Ac} = \frac{AB}{AC}$  or  $\frac{23.9''}{23.5''} = \frac{AB}{720''}$

- o  $AB = 732.3''$





# Triangulation



- o Using Pythagorean's theorem  
 $AB^2 = AC^2 + BC^2$
- o  $732.3^2 = 720^2 + BC^2$
- o  $BC^2 = 732.3^2 - 720^2$
- o  $BC^2 = 536117 - 518400$
- o  $BC = \sqrt{17717}$  (square root)
- o  $BC = 133.1$  inches
- o  $BC = 11.1$  feet

We know that the bullet hole in the seat is four feet above the ground, so the shooter is 15.1 feet above the ground

# Bullet Wounds – investigated to confirm or dispute witness's story.



1. **Entrance wounds** are smaller than exit because the skin is somewhat elastic and it stretches when a bullet enters the body. So wound is smaller than bullet.
2. **Exit wounds** are larger because the bullet moves through the body, it may collect and carry body tissue and bone with it.
3. When a bullet penetrates clothing first, fibers may be embedded in the wound.
4. Gunshot residue usually found at entrance wounds.



1. If the gun is fired with the muzzle touching the victim's skin, hot gases released from the muzzle flash may burn the skin, leaving a telltale mark.
  - o High-speed bullets are more likely to pass through a body than low-velocity bullets. Small-caliber bullets, (.22, .25 etc) tend to lodge within the body, while large-caliber bullets will pass through.





## ..... Summary .....

- Ballistics is the study of bullets and firearms.
- Firearms are divided into two groups—long guns and hand guns.
- Fired bullets show patterns of lands and grooves that match the rifling pattern in the barrel.
- A cartridge consists of primer powder, gunpowder, a bullet and the casing material.
- The caliber of a cartridge usually is a measure of its diameter.



## ..... Summary

- Investigators also check for firing pin, breechblock, extractor, and ejector marks.
- Gunshot residue can help recreate a crime.
- Using at least two reference points, an investigator can recreate a bullet's trajectory and determine where the shooter was located.
- Examining body wounds can determine where a bullet entered and exited the victim.