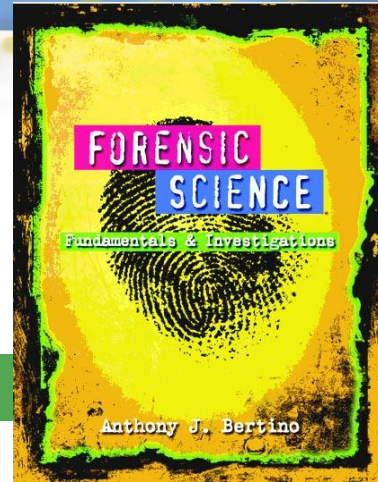


# Chapter 17 *Ballistics*

By the end of this chapter you will be able to:

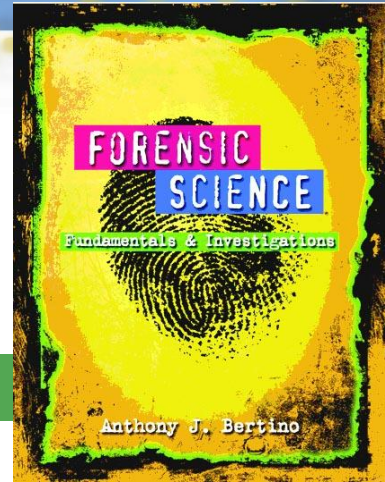


- Explain the differences between a handgun, a rifle, and a shotgun
- Describe rifling on a gun barrel and how it affects the flight of the projectile
- Explain barrel size and caliber

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# Chapter 17 *Ballistics*

By the end of this chapter you will be able to:



- Describe how bullets are test fired and matched
- Discuss the role of ballistics recovery and examination at a crime scene
- Determine the position of the shooter based on bullet trajectory

# 1. Define Ballistics

- o The study of projectiles (bullets) and firearms





## 2. Define Firearm

- o A weapon capable of firing a projectile using a confined explosive as a propellant.





# Introduction

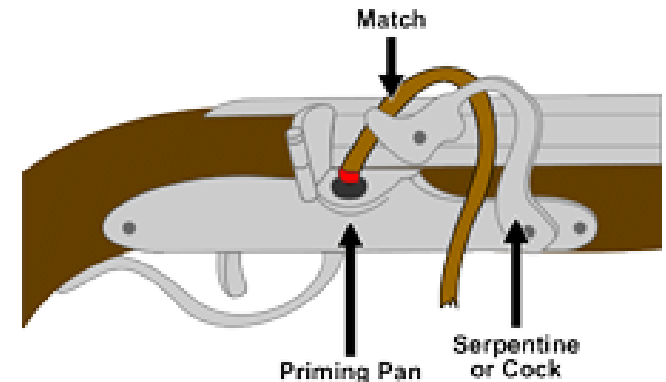
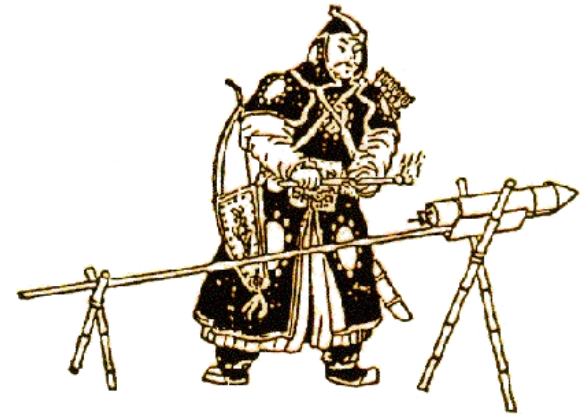
Ballistic evidence helps explain:

- 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



# 3. History of Gunpowder and Firearms

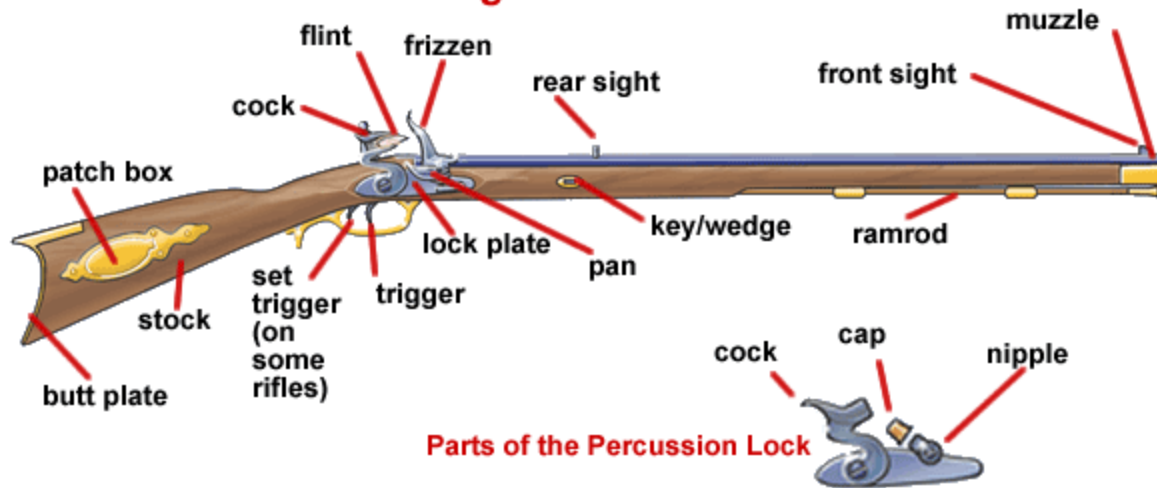
- Chinese invented gunpowder over a thousand years ago; used it for fireworks
- 14<sup>th</sup> century Europe – directed gunpowder down cylinder to fire a projectile
- Matchlock weapons – used wick to carry flame to gunpowder



# 3. History of Gunpowder and Firearms



**Parts of a Muzzleloading Flintlock Rifle**



- Flintlock – used sparks from a chip of flint; allowed to fire in wet weather
- Muzzle-loading – user puts gunpowder and projectile down the barrel



# 3. History of Gunpowder and Firearms

- o Cartridge and breech loading; percussion firing
- o Revolver, semi-automatic, and automatic handguns





## 5. Long Guns and Handguns

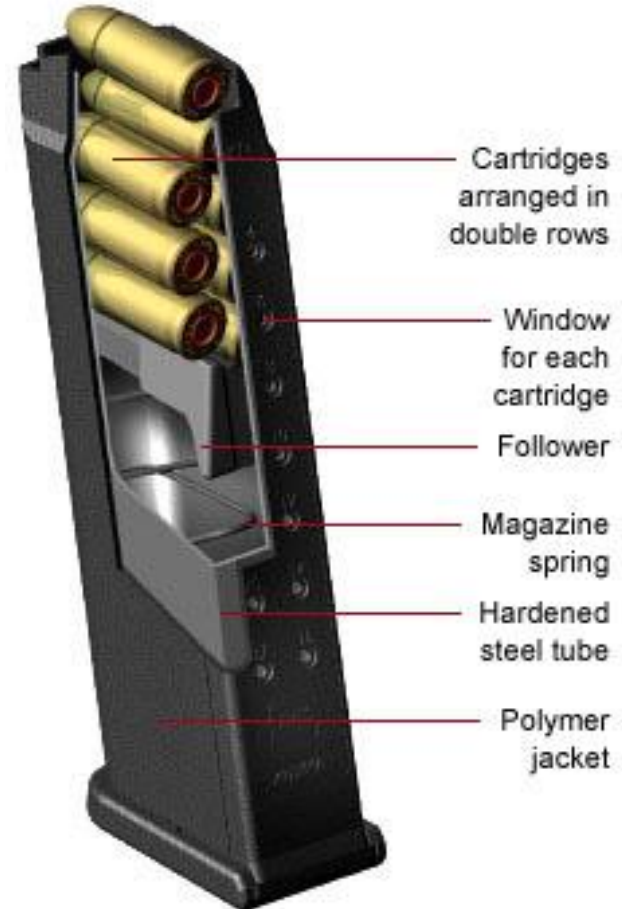
- o Long guns
  - Use 2 hands to fire accurately
  - Longer barrel makes shots more accurate
- o **(6&7) Two types**
  - A. **Rifles** fire bullets; wound will be small, round
  - B. **Shotguns** fire pellets (shot) or a single projectile (slug); wounds from shot will be small, superficial, and widespread; from slug much larger and deep.





# 5. Long Guns and Handguns

- o Handguns – 2 types
  - A. Pistols are fired with one hand; 10 or more cartridges are held in clip or magazine





## 5. Long Guns and Handguns

- o Handguns – 2 types
  - B. Revolvers – also with one hand; have a cylinder that holds usually six cartridges; first invented by Samuel Colt



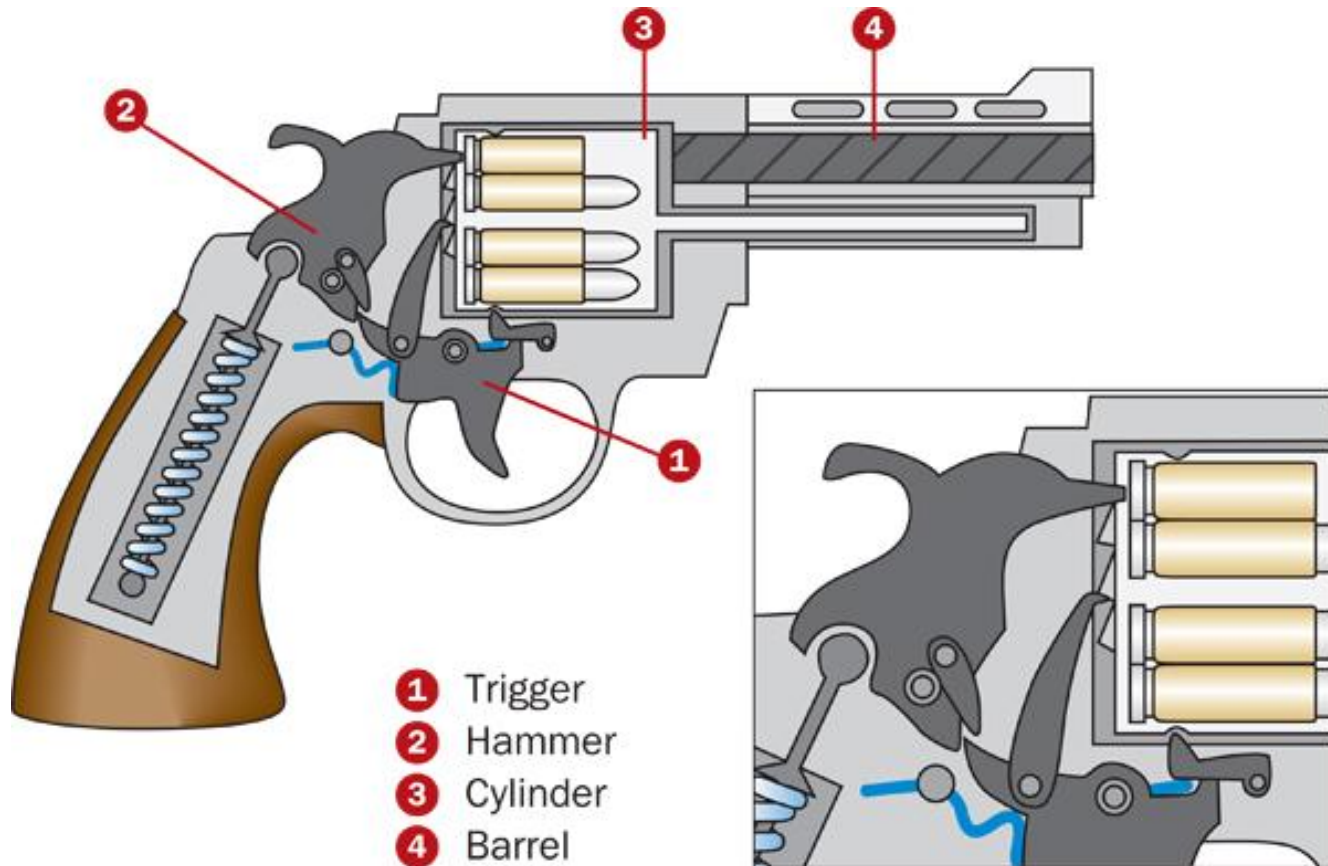


# Parts of a Hand Gun





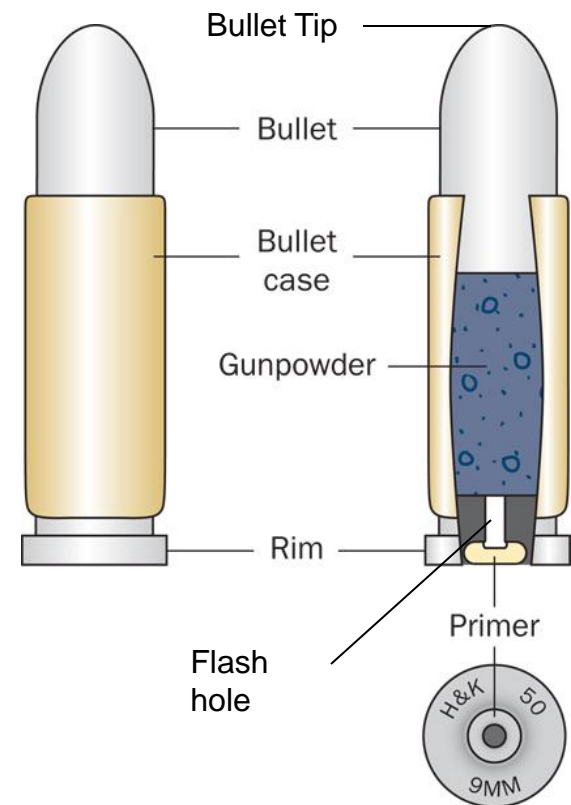
# Parts of a Hand Gun





# Bullets, Cartridges, and Calibers

- o Cartridge—a case that holds a bullet, primer powder, and gunpowder
- o The bullet, usually of metal, is out front with the cartridge, holding the primer and propellant powders, behind.





# Caliber of the Cartridge

- Caliber—a measure of the outside diameter of the cartridge; also measure of inside diameter of barrel
- In hundredths of an inch or millimeters
- Common calibers in hundredths of an inch 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?



# Classification of guns

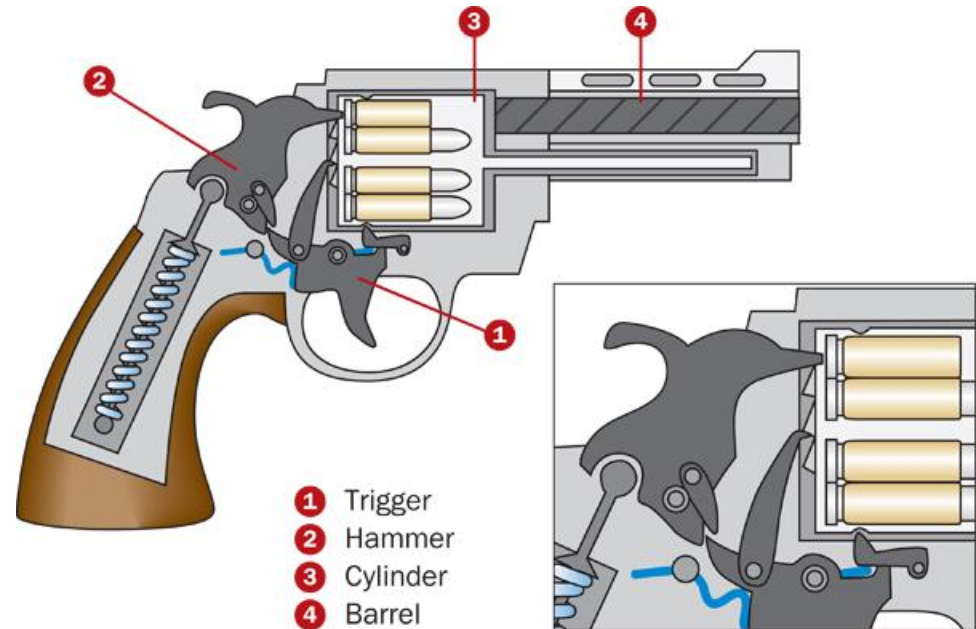
- Semiautomatic weapons – fire only one bullet per pull of the trigger
- Fully automatic – fire repeatedly as long as trigger is pressed.
- In both, empty cartridge ejects (often can be found at crime scene) and next cartridge advances automatically.





# How a Firearm Works

1. After trigger pull, the firing pin hits the base of the cartridge, igniting the primer powder

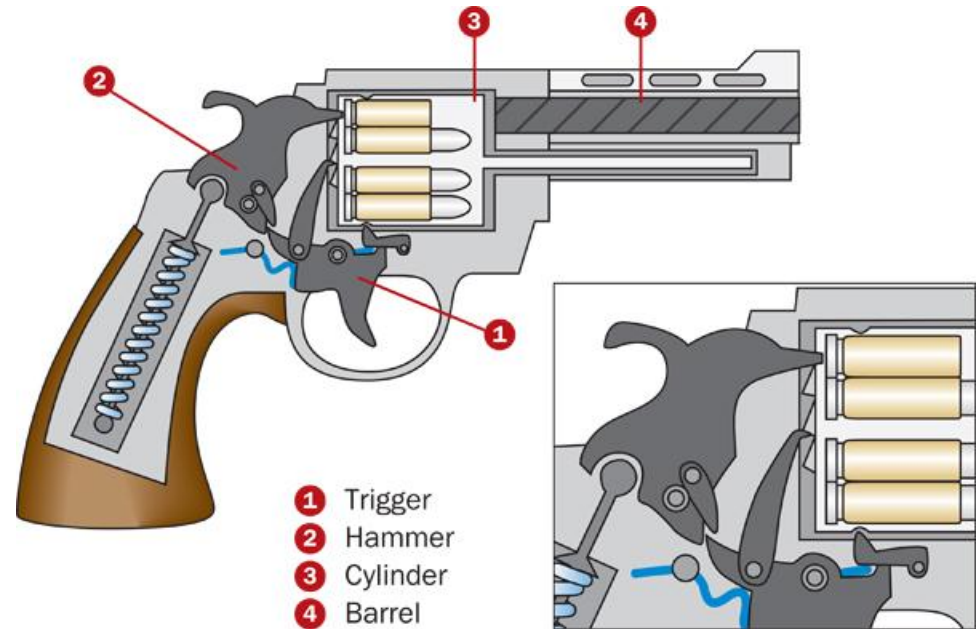


2. The primer powder sparks through the flash hole to the main propellant supply



# How a Firearm Works

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

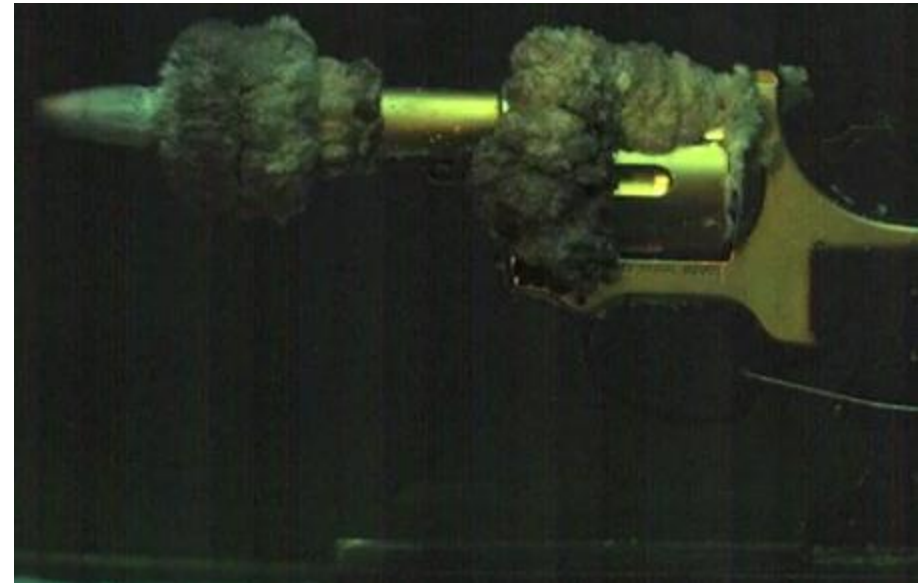


4. The bullet follows the lands and grooves spiraling out of the barrel



# Energy causing the bullet to fire

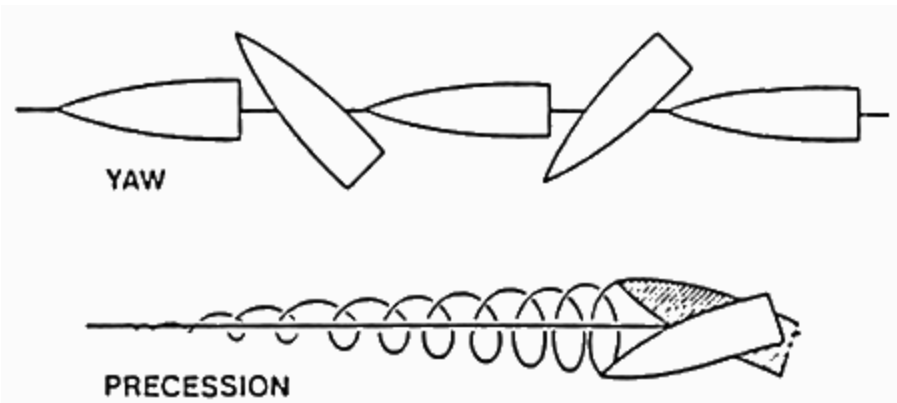
- o Smarter every day video





# Physics outside of the barrel

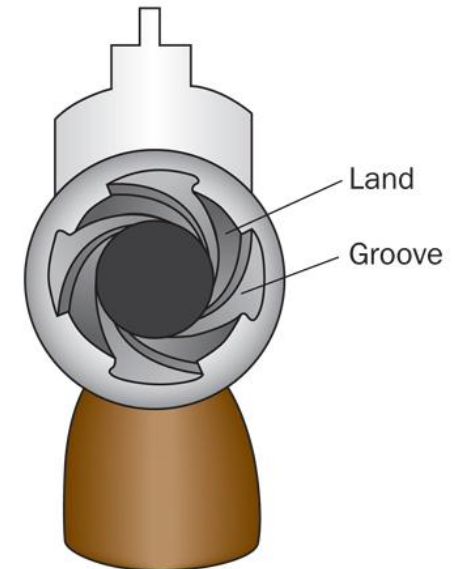
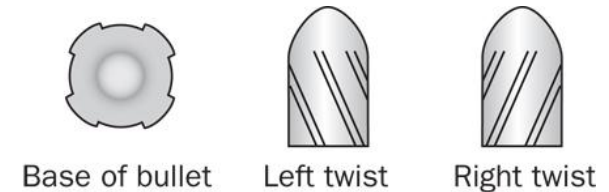
- **Yaw** refers to the rotation of the nose of the bullet away from the line of flight.
- **Precession** refers to rotation of the bullet around the center of mass.





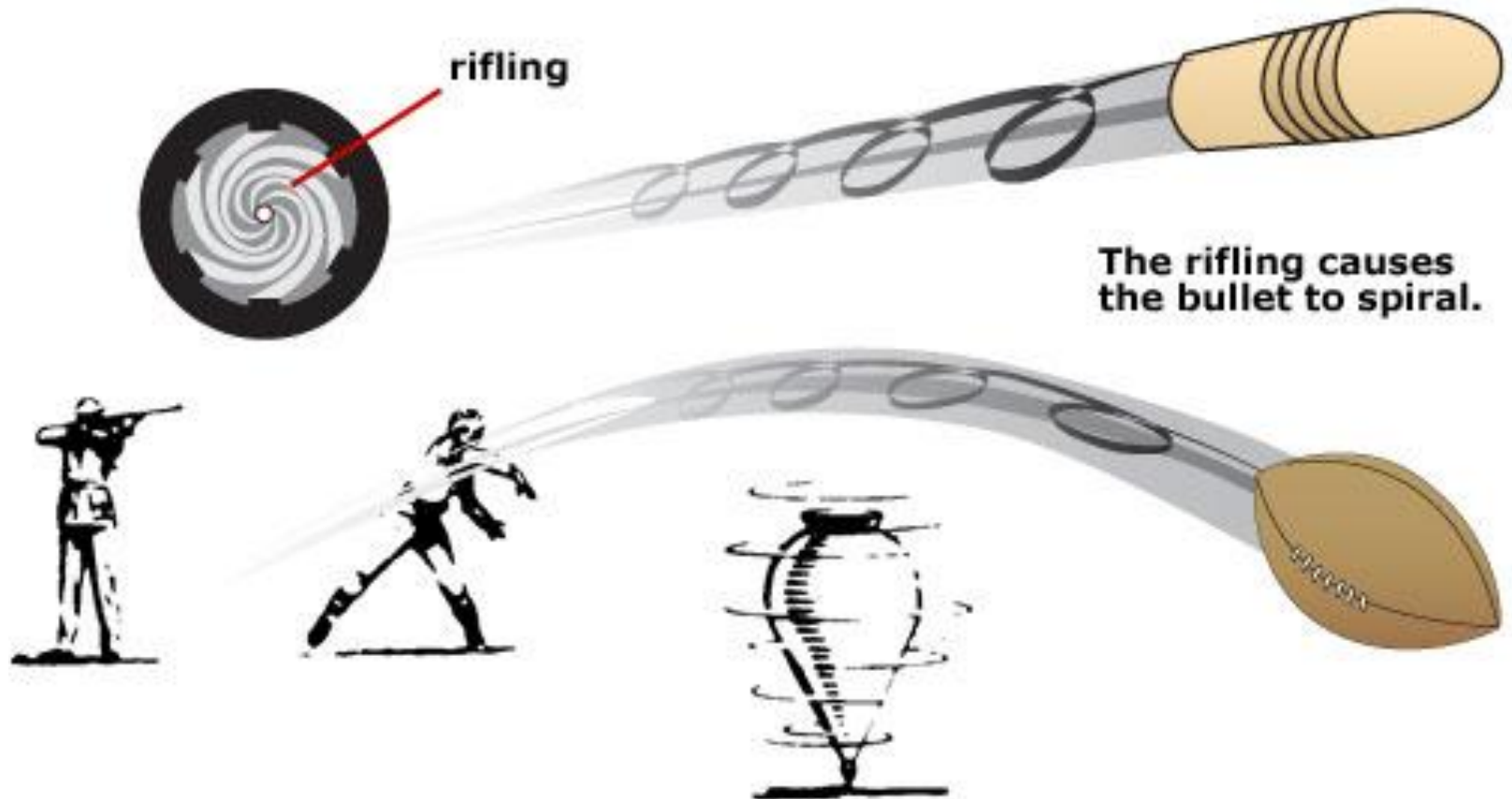
# Firearms and Rifling

- o **Grooves** and ridges (**lands**) in the barrel of a gun produce the twisting that adds accuracy
- o This leaves a pattern on the bullet that is unique
- o Rifling video





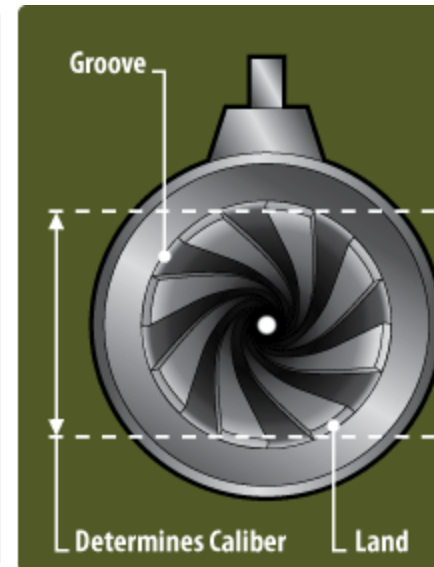
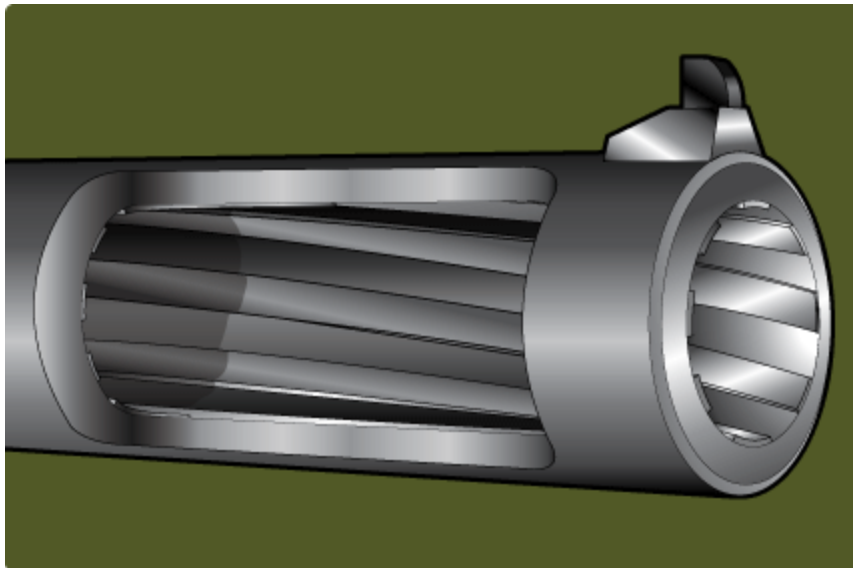
# Rifling adds accuracy





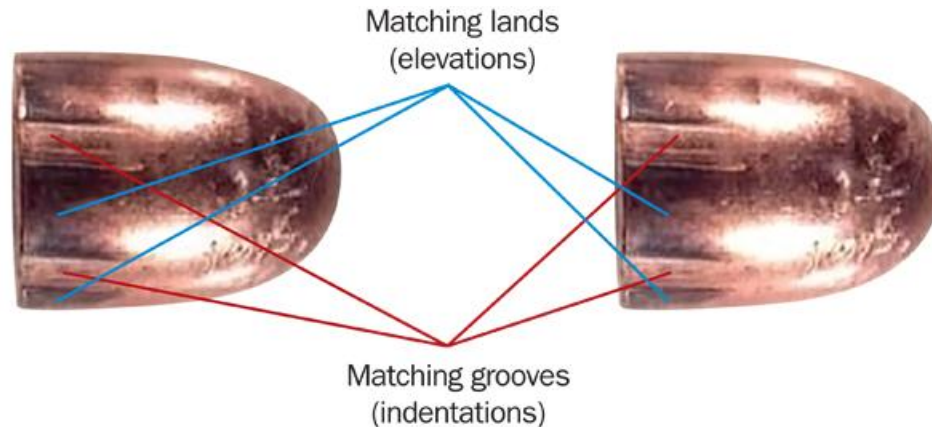
# Firearms and Rifling

- o Ridges (lands) within the barrel will leave grooves on the bullet.





# The Study of Bullets and Cartridge Casings



1. How is each fired bullet marked?
2. What is the procedure to match a spent bullet to the firearm that shot it?
3. What makes up a test-firing, and why is it done?

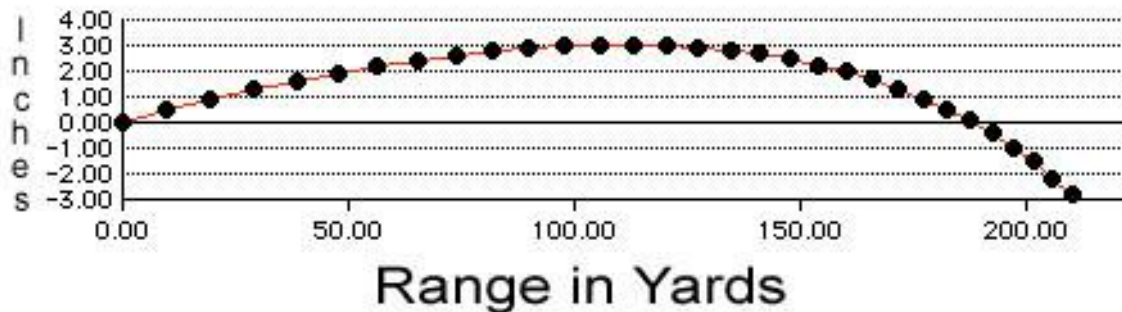




# Projectile Motion

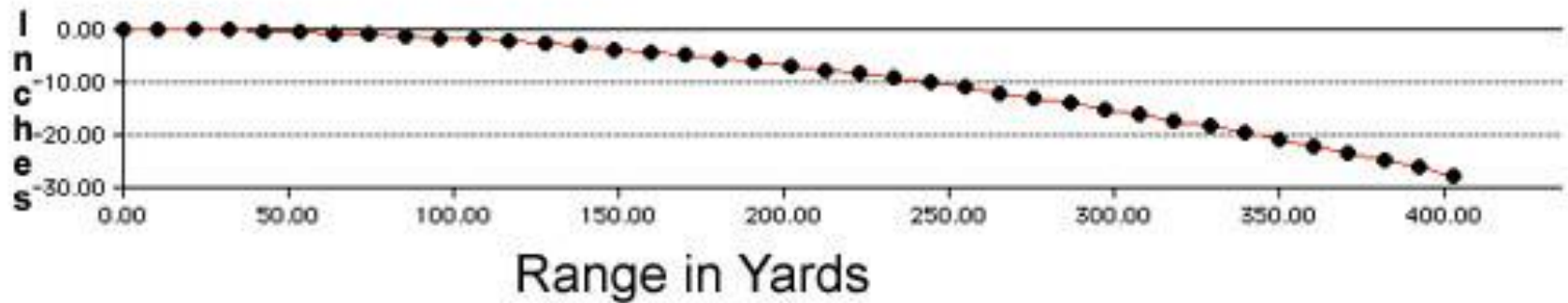
- **Projectile motion is an example of curved motion with constant acceleration. It is two dimensional motion of a particle thrown obliquely into the air.**

Typical Hunting Rifle Trajectory  
3000 fps Muzzle Velocity





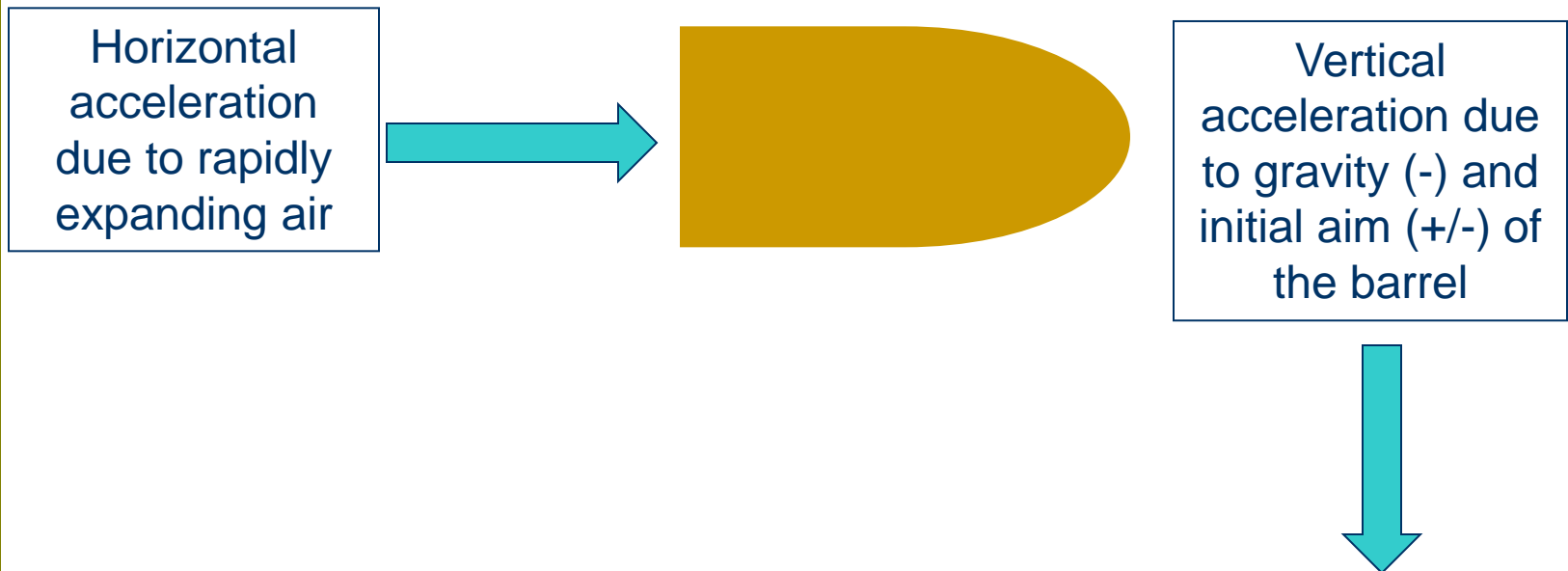
## Horizontal Rifle Trajectory 3200 fps Muzzle Velocity





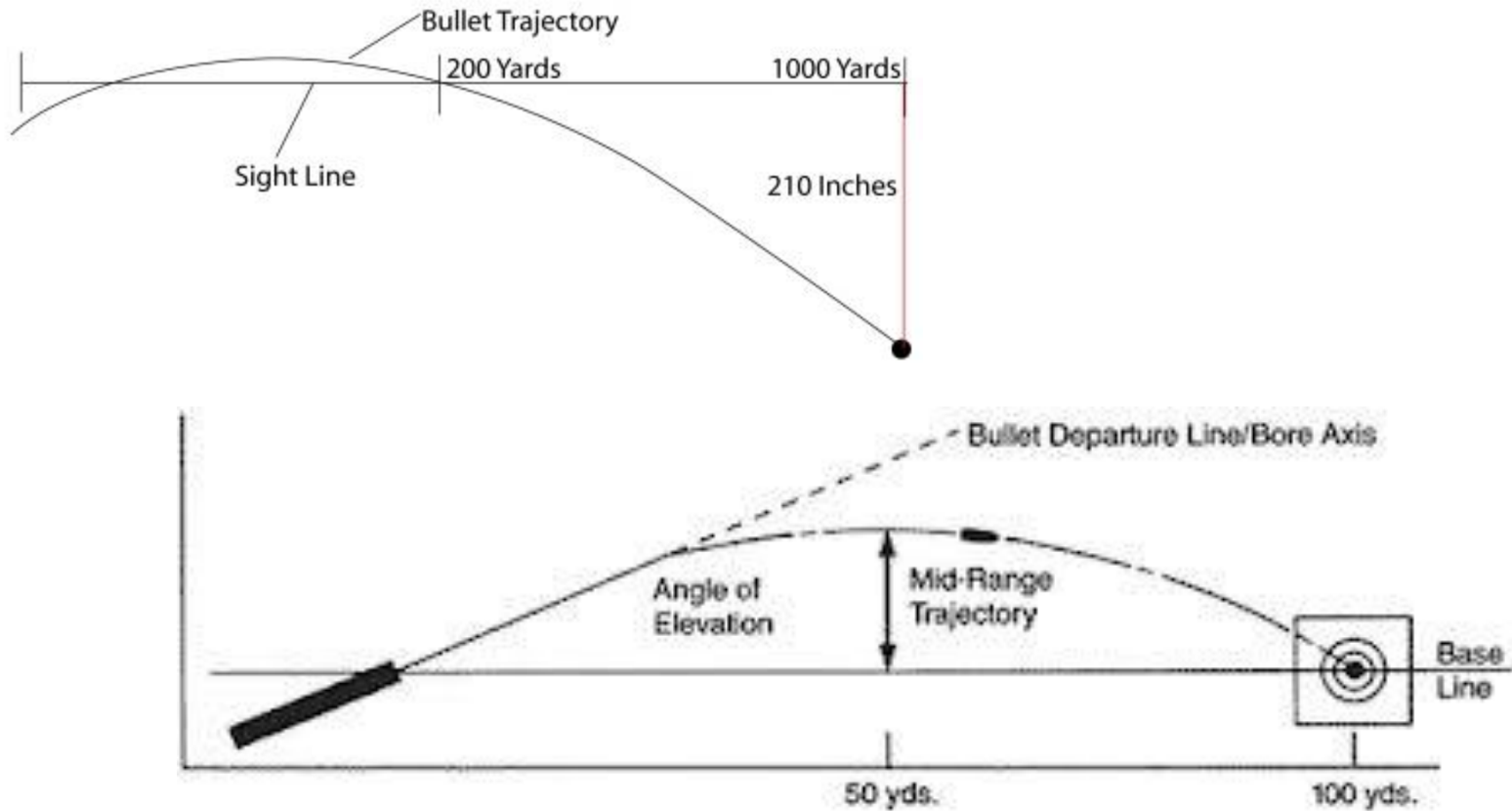
# Projectile Motion

2 main forces acting on a fired projectile





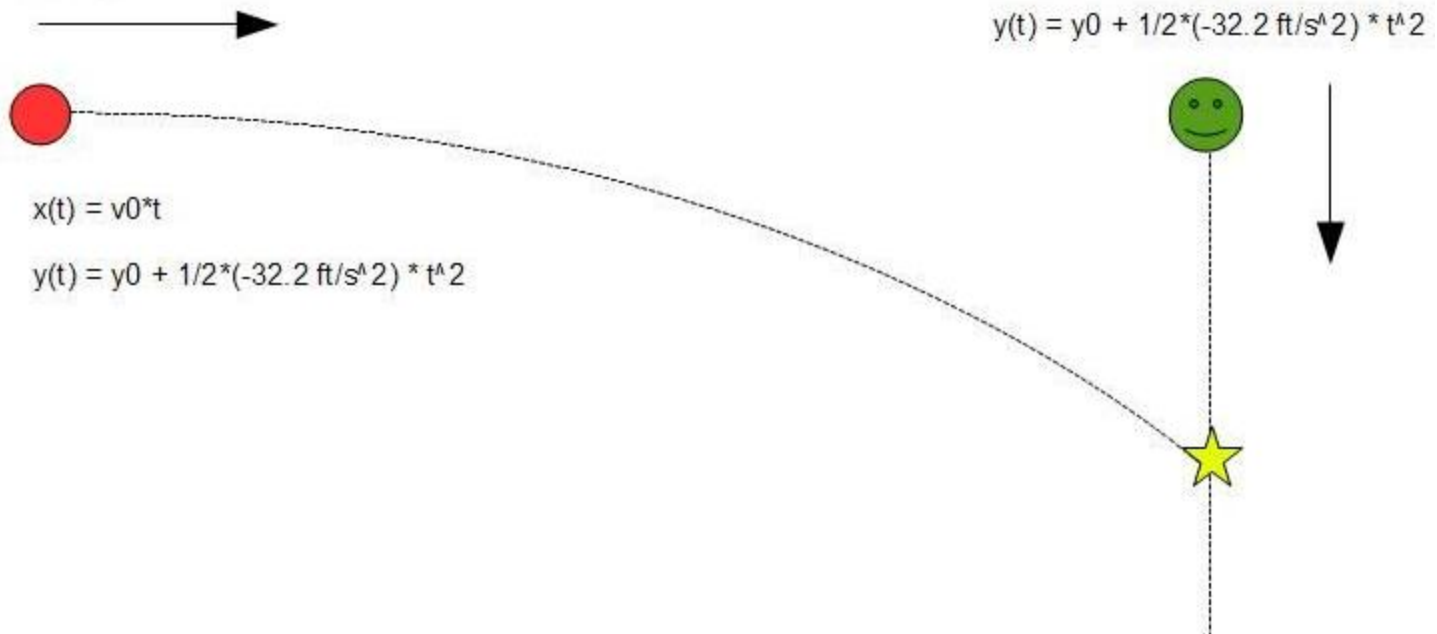
# Projectile Motion





# Projectile Motion

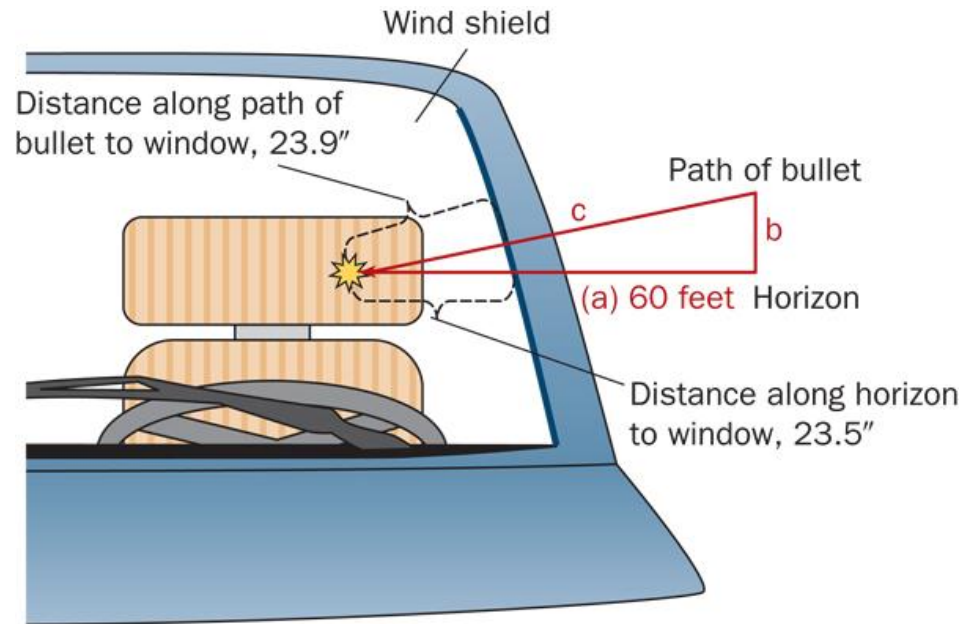
- o Which falls first? A fired bullet or a dropped bullet





# Trajectory

- 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



# FBI Handbook on Firearm Examinations

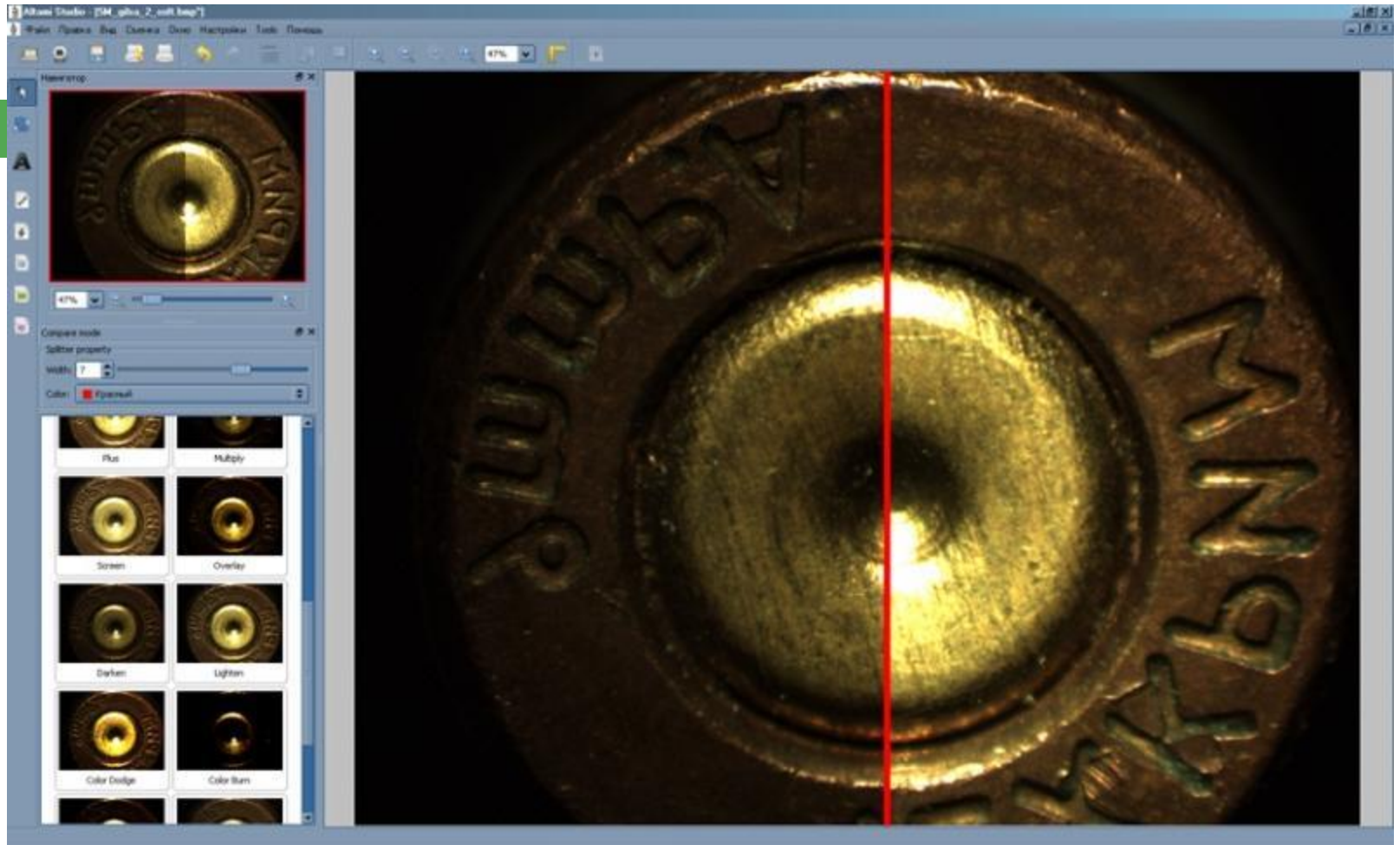
## 1. Bullets

- Determine caliber, rifling impressions, and bullet manufacturer
- Microscopic characteristics can be compared with test-fired bullets for an association

Comparison Microscope – allows viewing of two different objects side-by-side

developed by Calvin Goddard – Father of Ballistics









# FBI Handbook on Firearm Examinations

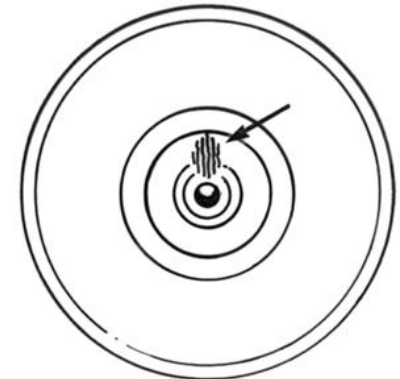
## 2. Cartridge cases or Shotgun casings

- Determine caliber or gauge, manufacturer, and whether there are marks of value for comparison
- NIBIN – National Integrated Ballistic Information Network; ran by ATF - Bureau of Alcohol, Tobacco, Firearms and Explosives

# Marks on the Spent Cartridge Casings



- Firing pin marks
  - appear on the 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
- Ejector marks





# FBI Handbook on Firearm Examinations

## 3. Unfired Cartridges or Shotshells

- Determine the caliber or gauge and whether there are marks of value for comparison
- Can determine if ammunition was ever loaded in and extracted (extractor marks) from a specific firearm
- Also look for manufacturing marks



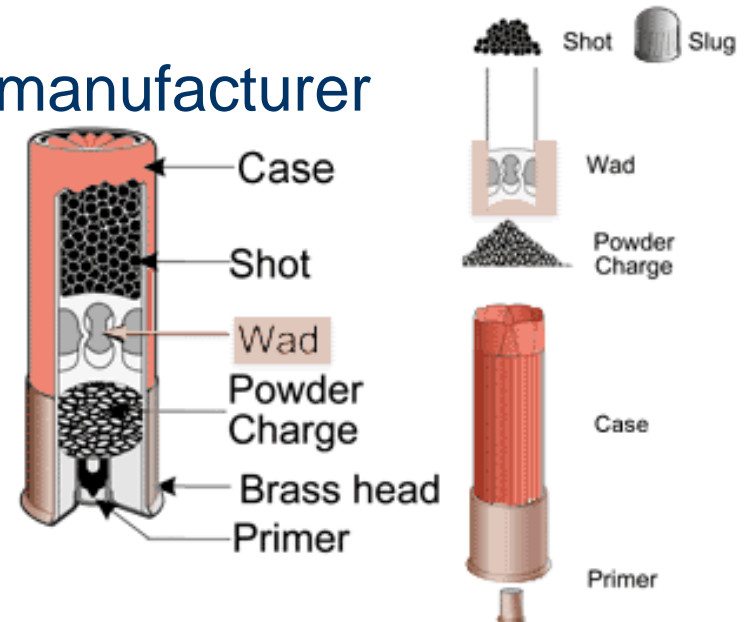
# FBI Handbook on Firearm Examinations

## 4. Shot Pellets, Buckshot, or Slugs

- Determine size of the shot, gauge of the slug, and manufacturer

## 5. Wadding

- Determine the gauge and manufacturer





# FBI Handbook on Firearm Examinations

## 5. Gunshot Residues (GSR)

- Particles of unburned powder 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



# FBI Handbook on Firearm Examinations

## 6. Gun Parts

- Can determine caliber and model of a gun from which the parts originated

## 7. Silencers

- Test if muzzle attachment can be classified as a silencer





# Bullet Wounds

- o Why do entrance wounds tend to be smaller than exit wounds? **The skin is somewhat elastic and stretches as bullet enters. As bullet moves through the body, it may collect and carry body tissue and bone with it.**
- o If the bullet penetrates clothing, what can fibers embedded in the wound indicate? **Point to the direction of penetration.**
- o Where is gunshot residue usually found? **GSR is usually found near entrance wound.**



# Bullet Wounds

- o If the gun is fired with the muzzle touching the victim's skin, what telltale mark may show up? **Hot gases released from the muzzle flash may burn the skin, leaving a telltale mark.**
- o Will larger or will smaller caliber bullets tend to lodge within the body rather than passing through? **Why? Smaller caliber tend to lodge within the body, while larger 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.