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Subject: **Law**

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Paper : **Forensic Science & Forensic Medicine**

Module : **27, Internal and external ballistics, identification of firearms and ammunition**





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DESCRIPTION OF MODULE

Items	Description of Module
Subject Name	Law
Paper Name	Forensic Science and Forensic Medicine
Module Name/Title	Internal and external ballistics, identification of firearms and ammunition
Module Id	LAW/CJA/VIII /
Objectives	<p>To understand the role of ballistics in Forensic Science, internal and external ballistics, factors affecting external ballistics</p> <p>To correlate a suspected firearm recovered from the crime scene and fired bullet/cartridge</p> <p>Study of the different marks produced on the bullet, cartridge after firing</p>
Prerequisites	Introduction to ballistics, ballistics terminology.
Key words	External ballistics, bullet, cartridge, striation marks, firing pin marks, identification



The term ballistics refers to the science of the travel of a projectile in flight. The flight path of a bullet includes: travel down the barrel, path through the air, and path through a target.

There are three types of ballistics, internal, external and terminal.

Internal Ballistics:

Internal ballistics is the study of what happens inside the firearm from the moment the trigger is pulled, firing pin hits the primer to the time until the bullet exits from the barrel. It is mainly concerned with propellant pressures, acceleration of the missile whilst it is in the bore, muzzle velocity and recoil.

When the firing pin strikes the primer, the priming compound explodes causing an extremely high temperature jet of flame to pass through the flash hole and into the propellant charge. This jet of flame, which is about 2000°C, ignites the propellant powder which burns at high speed to form a large volume of gas. This high - pressure gas accelerates the bullet down the barrel and out of the muzzle.

Nitrocellulose, which is the main propellant in modern firearms if ignited in an unconfined space burns gently. If it is in a confined space, the heat and pressure built up will accelerate the rate of combustion exponentially.

In a weapon, the propellant is confined within the cartridge case, the mouth of which is closed with a bullet. The round of ammunition is then supported by the chamber walls and standing breech of the weapon. Under these conditions, the pressure build - up will continue until it is sufficient to overcome the inertia of the bullet and start its acceleration down the bore. The heavier the bullet, the greater the resistance and the higher the pressure. The higher the pressure, the greater the rate of combustion.

External Ballistics:

External ballistics is the study of the missile's flight from when it leaves the muzzle until it strikes the target. The two main factors which affect the performance of a bullet on leaving the barrel are air resistance on its nose and the effect of the gravitational pull of the earth. As a result of these forces, the bullet will, on leaving the barrel, describe a downward curved path or trajectory.

The exact shape of this trajectory can be predetermined by knowing:



- The gravitational effect;
- The muzzle velocity;
- The angle of elevation of the barrel;
- The sectional density of the bullet;
- The bullet shape.

Terminal Ballistics:

Terminal ballistics deals with the behaviour of the missile once it reaches the target. This is obviously not concerned with simply piercing a paper target, but what the missile does once it encounters a material considerably denser than air. Whilst this will usually be concerned with the missile's performance and wounding capabilities in animal tissue, this could also include its performance in water, soil, brick, concrete, wood or bullet resistant materials.

Terminal ballistics is the study of missile penetration in solids and liquids. It can be subdivided into penetration potential, which is the capability of a missile to penetrate various materials and wound ballistics, which is the effect the missile has on living tissue.

Identification of firearms and ammunition

Firearms identification is often treated as a subspeciality of toolmark identification. A toolmark expert attempts to match tools like screwdrivers and crowbars to the marks they make when used on objects. "Ballistics" experts are more than toolmark specialists. They are generally experts in many aspects of firearms and testify about topics ranging from whether a specific object is, legally, a firearm, to intricate reconstructions of crime scene evidence.

When investigators find a bullet at a crime scene, it can tell an examiner the caliber of the gun that fired it, the type of bullet, and possibly the manufacturer and model of the firearm. If police find expended cartridge cases, these also indicate the caliber of the weapon used, its type (rifle/shotgun/revolver/semiautomatic pistol), and possibly the firearm's manufacturer.

If police also recover a gun from a suspect, an expert would likely be able to match the bullet and cartridge case to that specific firearm. Experts can do this by looking at



the marks the firearm makes on the cartridge and the bullet as it is fired. When a cartridge is fired, the firing pin strikes the primer. This impresses the firing pin's mark into the soft metal of the primer. The primer contains a tiny bit of explosive, which, when hit, ignites the propellant. The propellant burns rapidly, producing gases that exert pressure in all directions—on the head of the cartridge case, on the walls of the cartridge case, and on the bullet.

The bullet is the only part able to move, and is forced out of the barrel, leaving the cartridge case behind. Most firearms have a rifled barrel. Parallel spiral grooves are cut into the inner surface of the barrel. The space between the grooves is called the lands. The grooves twist to the right or left. The number of grooves, their width and depth, and the angle of the twist (pitch) vary by manufacturer.

As a bullet passes through the barrel, it engages the lands, forcing the bullet to rotate. The spin acts like a gyroscope to stabilize the bullet and keep its nose pointed in a consistent direction. The spin makes the bullet more accurate over longer ranges. Because the bullet literally scrapes along the side of the barrel, the land and groove's impressions and other microscopic details are etched into the side of the bullet. These fine microscopic details are called striations or striae.

A cartridge case may also receive striated marks from the extractor and magazine lips in firearms that have these features. Newton's third law requires an equal and opposite reaction to any action. When a bullet is fired, the cartridge is pressed into the breech by the gas pressure. This impresses any marks on the steel breech face onto the back of the softer metal cartridge and the primer. The primer is also pressed back toward the firing pin, which may further impress its mark. The cartridge case may also be marked by the ejector in a firearm, which has this mechanism. These marks are called impressed marks. The marks, which identify the gross properties of the firearm—caliber, number of lands and grooves, and direction of rifling twist—are the firearm's class characteristics. The marks are often visible to the naked eye. These will be the same for any bullet fired from any firearm of the same make and model, and often of several different makes and models.



Trying to match a recovered bullet or cartridge case to a specific firearm is more difficult. Firearm identification assumes that there are individual characteristics that are unique and consistent to one specific firearm. In theory, it is not possible to make two machined surfaces that are microscopically identical. Even rifled barrels manufactured consecutively can be distinguished because the cutting and grinding tools are blunted and worn each time they are used, leaving minute variations. Similarly, firing pins and the breech are believed to leave unique markings. Normal wear and maintenance, corrosion, rust, dirt, and debris will change markings over time, creating both permanent individual characteristics and temporary accidental characteristics. These changes can make it easier to tell one firearm from others made by the same manufacturer.

If a firearm is recovered, the examiner compares microscopic marks on the cartridge or bullet recovered from the crime scene with test bullets and cartridge cases fired from the recovered weapon into a water tank or bullet trap to see if the markings are consistent. If no weapon has been recovered, the examiner compares the crime scene bullets to each other, and the cartridge cases to each other, to see if the markings are consistent

Bullet class characteristics:

- Caliber of Bullet
- Composition of bullet
- Number of lands and grooves (usually 4 to 6 but range from 2 to 22).
- Diameter of lands and grooves.
- Width of lands and grooves.
- Depth of grooves.
- Degree of twist (twist is the number of inches/cms of bore required for one complete rifling spiral).
- Direction of rifling twist (commonly right/clockwise, less commonly left/counter- clockwise e.g. Colt).

Bullet individual characteristics:

- Imperfections of grooves (most pronounced in lead bullets).
- Imperfections of lands (most pronounced in jacketed bullets).



- Striation Marks produced on the bullet surface due to the imperfection of the internal of the barrel

Class and individual characteristics on the cartridge case

- Type of breech block marking
- Size, shape and location of extractor marks
- Size, shape and location of ejector marks
- Size, shape and location of firing pin marks and firing pin drag marks
- Chamber marks
- Magazine marks

Fingerprints are rarely recovered from firearms but may be obtained from cartridge cases.

Number and twist of Lands and grooves: The Number of lands and grooves are the amount of hill and valley protruding up and down in a helical pattern within the bore, while the twist of the lands and grooves is the direction in which the helical patterns move in the bore of a firearm which has been subjected to conventional rifling.

The width, depth, and pitch of lands and grooves: The width of the lands and grooves is the distance between two lands; the depth of the lands and grooves is how deep the raised portion of the barrel is to the actual caliber of the firearm; the pitch of the lands and grooves is the angle of the groove edge relative to the width and steepness of the groove. These are all class characteristics which also imparted from a firearm to a fired bullet.

Caliber of the weapon: The caliber of the weapon is the diameter of the bore measured from land to land. The caliber is one of the most obvious class characteristics which is also imparted during the making of bullets

Class characteristics of cartridge case

Some Class Characteristics of cartridges are due to the impressions/markings imparted from the weapon to which it was fired from; other class characteristics can be linked to the manufacturer, and make of the cartridge for a particular weapon and purpose

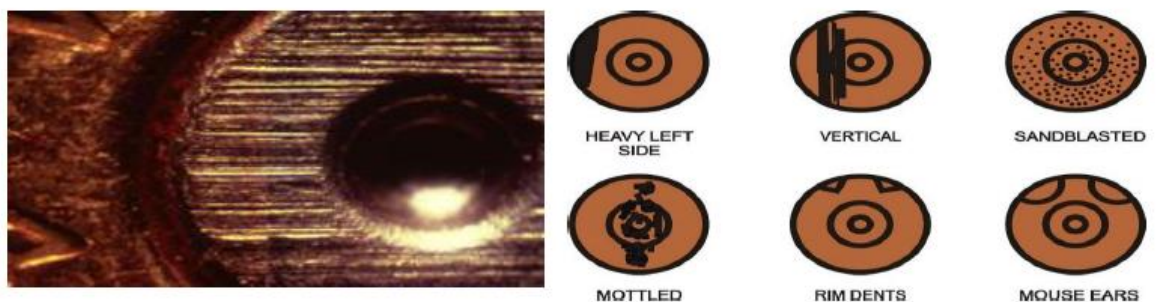
Firing pin impressions: Indentation of the primer of a centerfire cartridge case or the rim of a rimfire cartridge case when struck by the firing pin



– Showing Different firing pin marks imparted by two different types of weapons (Glock and Smith and Wesson).

Firing pin drag marks: Striated tool marks produced when a projecting firing pin contacts a cartridge or shot shell during extraction and ejection.

Breech face marks: Negative impression of the breech face of the firearm found on the head of the cartridge case and/or primer after firing



Primer shearing marks: Striated tool marks caused by the rough margins of a firing pin hole (aperture) scraping the primer metal during unlocking of the breech of a firearm

Chamber marks: Individual microscopic marks placed on a cartridge case by the chamber wall as a result of chambering, expansion during firing or extraction



Extractor marks: Striated tool marks produced on a cartridge or cartridge case from the operation of an extractor (usually found on or just ahead of the rim)

Ejector marks: Tool marks produced on the head of a cartridge case, from contact with the ejector (generally at or near the rim)

Ejection port marks: Striated marks produced by hard contact between the ejection port of a firearm and a rapidly moving ejected cartridge case

Magazine marks: Striated marks produced on the periphery of a cartridge as it moves from the lips of a magazine towards the chamber during feeding

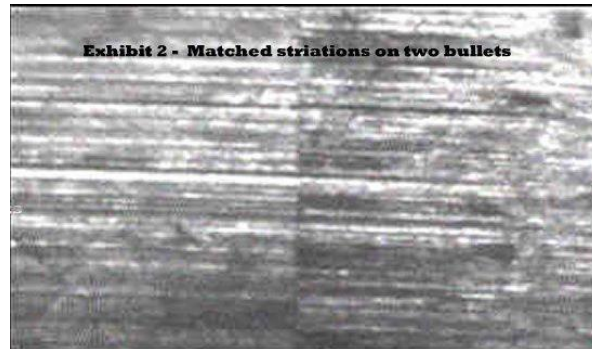
The Manufacturer of the Cartridge: This is the company which manufactures cartridges for various types or a specific type of weapon

Shape and Caliber of Cartridge: The Shape of the cartridge speaks to whether the cartridge was designed for rimmed, rimless or belted firing; while the caliber is the size of the cartridge as it relates to the type of weapon which it can be fired from.

Cartridge Composition: This speaks to the material used to compose the cartridge. Some cartridges are designed with harder materials to facilitate the high pressure heat during firing, some of these cartridges spent casings can be reused; Other cartridges are designed in order to not degrade or to lose luster and strength over time; while some are made with materials such as paper or plastic relative to particular weapon.

Individualizing characteristics of Firearm and Bullet:

Striations in the lands and grooves of a firearm, and the lands and grooves of a fired bullet. Striations are imparted into the bore of a firearm during rifling, as the lands and grooves or are being formed inside the barrel of a firearm. These lands and grooves along with their striations then impart themselves onto the bullet when it is fired from a weapon. The striations in the lands and grooves of the weapon will provide a direct link to the rifling process and manufacturer that made the weapon; while the striations in the lands and grooves from a fired bullet will provide a direct link to the bore of the specific firearm it was fired from, as well as a direct link to other bullets fired from the same weapon.



Individualizing characteristics of Firearm and Cartridge

Type of Breech-face mark: The area around the firing pin, which is against the head of the cartridge or shotshell during firing is the Breech face. Different weapons have different types of Breech face marks. Eg. Glock pistols possess a rectangular Breech face pattern, as opposed to a 9mm Luger LC pistol. Within the Breech face pattern, there are minute impressions which can be identified microscopically; these are the individual characteristics which are imparted onto the cartridge casing when its head is forced back onto the Breech block during discharge of the firearm.

Shape of ejector and extractor marks: The shape of ejector and extractor marks are also imparted onto the cartridge after firing. The ejector and extractor can impart individualizing characteristics on the head of the shell casing, based on the theory that no two ejector and no two extractor is shaped the same way.

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