Directions: Read the article below. After reading, on a separate sheet of paper, write 10 quiz questions (multiple choice or matching) that could be answered with the information below.

History of Firearms

For millennia man has been fascinated with the idea of launching a projectile at animals--or men of opposing points of view--and has developed more efficient ways of doing so.

- The invention of gunpowder led to the development of firearms. Gunpowder first appeared in use in China over a thousand years ago, but was used primarily in firecrackers and only sparingly in weapons for military use.
- Dissemination of the knowledge of gunpowder manufacture to Europe in the 14th century did not at first lead to military usage.
- However, once the effectiveness of projectiles impelled by the force of gunpowder against both the armor of knight-soldiers and fortifications was known, the use of firearms proliferated rapidly.

Gunpowder, made of a mixture of sulfur, charcoal, and saltpeter (potassium nitrite), owes its explosive force to the fact that 1 mole of solid powder will, when ignited, produce 6 moles of gas. This rapid expansion in the enclosed space of a metal tube could be used to drive a projectile at high speed in a specified direction. Modern gunpowder is simply a refined version of the primitive substance in which the chemical composition has been altered to provide the greatest expansion with the smallest quantity and the least residue. The manufacture of modern powders is standardized enough that gunpowder residue can be analyzed by methods which identify specific components, which can aid the forensic scientist greatly. We will enlarge upon this subject later on.

The greatest stimulus for firearms development was and continues to be military usage. The important needs, militarily speaking, for a firearm included the following: reliability of firing, accuracy of projectile, force of projectile, speed of firing. The reliability issue sparked the development of a number of mechanisms to ignite the powder.

Firing mechanisms developed included:

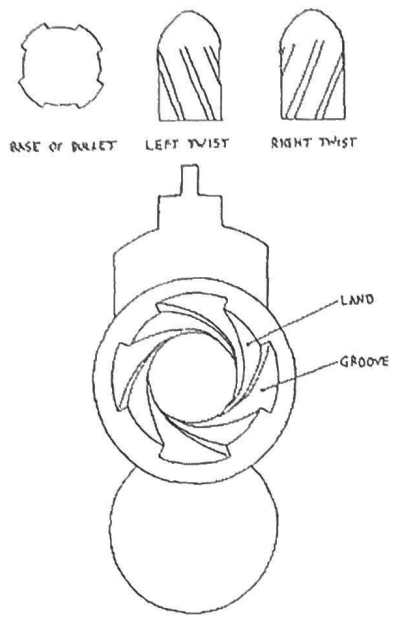
- Matchlock: Primitive matchlock weapons employed a burning wick on a spring that was "locked" back and released into a pan of powder upon pulling a trigger. The powder in the pan then ignited, sending flame through a small hole into the

barrel chamber of the weapon, igniting a larger powder charge in the chamber and sending the projectile (bullet) forward.

- Wheellock: In the early 16th century, improvements included the wheellock mechanism in which a spinning wheel against a metal plate showered sparks into the "pan" holding "priming" powder.
- Flintlock: The flintlock developed in the yearly 17th century has a flint was released by the trigger mechanism that strikes a steel plate to shower sparks into the pan filled with powder.
- Percussion: The "percussion" ignition mechanism evolved next in the 19th century and consisted of a "hammer" that was locked and, when released, struck a cap containing a volatile "primer" that ignited on impact, sending a flame through a small tube into the barrel chamber.

Next, inventors combined the individual components including the bullet, powder charge, and primer all in a single cartridge which could be introduced directly into the chamber. Up to that point, "muzzle loaders" had the powder and bullet loaded from the top of the barrel. These weapons had a "smooth bore" with a round lead ball, both of which limited range and accuracy.

The accuracy issue was partially solved by using weapons with a longer "bore" or length of metal tube, but there was always a limit to the size of weapon you could carry around. In the 18th century, gunsmiths discovered that putting spiral grooves in the bore would impart a spin to the bullet that improved accuracy markedly. However, grooves had originally been cut to reduce the problem of "fouling" from unburned powder residue. Thus, all modern weapons have "rifling" in their barrels.



Accuracy improved with the use of rifling - metal lands and grooves with a twist inside the barrel of the gun. The bullet gripped the rifling that imparted a spin to the bullet as it traversed the barrel. The spinning bullet that left the barrel had more stability with less tumbling in flight. This produced a more consistent and longer flight path. Thus, accuracy and range improved.

This rifling is slightly different for each weapon, imparting different patterns of deformation on the bullet. These patterns can be used by the forensic scientist to aid identification of a particular weapon used in a crime.

The "breechloading" firearms developed in the late 19th century led to another advantage--speed of loading. Further improvements consisted of multiple chambers, as in the revolver, for multiple shots. Other mechanisms included various "actions" associated with sliding or pumping motions that loaded successive cartridges into the chamber--the so-called "repeating rifle." Toward the end of the 19th century, inventors like Henry Maxim and Richard Gatling devised schemes for rapidly firing large numbers of "rounds" or cartridges without stopping, thus developing the "machine gun."

Machine guns firing multiple bullets were developed in the late 19th century and were refined in World Wars I and II. Modern assault weapons used by armies around the world utilize a mechanism in which the expanding gasses of the gunpowder provide the force for cycling the mechanism to shoot multiple rounds--up to 600 rounds per minute.

The force of a projectile is related to the kinetic energy (KE) imparted to it, given by the formula:

$$\text{Kinetic Energy} = 1/2\ MV^2 \text{ where M=Mass and V=Velocity}$$

Historically, KE has been enhanced in two ways:

- The first way the KE was enhanced was increasing the "caliber" of the weapon. Caliber refers to the diameter of the bore of the barrel, given in decimal fractions of an inch or, in metric systems, in millimeters. Thus, a handgun or rifle could be referred to as .45 cal or .38 cal (called 45 caliber or 38 caliber) or 9mm.

- The second way modern weapons increase KE is through velocity, as impelled by modern gunpowder, which increases the force tremendously because it increases KE as a square of any increment of improvement in velocity.

Velocities of bullets increased with the use of a "jacket" of a metal such as copper or copper alloys that covered a lead core and allowed the bullet to glide down the barrel more easily than exposed lead. Such bullets are designated as "full metal jacket" (FMJ). Such FMJ bullets are less likely to fragment on impact and are more likely to traverse through a target while imparting less energy. Hence, FMJ bullets impart less tissue damage than non-jacketed bullets that expand. (Dougherty and Eidt, 2009) This led to their adoption for military use by countries adhering to the Hague Convention in 1899.