THE CRUSADERS

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By Kaleigh Rhoads

The Crusades: Weapons, Battles, and Physics?

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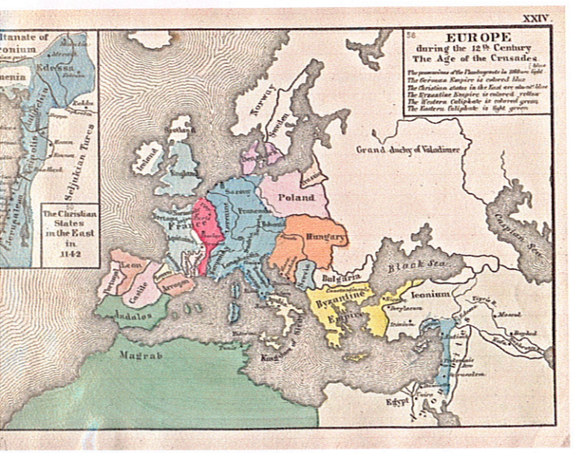
The Crusades

The Crusades

The word "Crusade" generally refers to any of the religious, military, political, and commercial expeditions of the Catholic church in the middle ages against non-Catholics. November 27, 1095 AD, Pope Urban II began preaching his desire to regain control of the sacred city of Jerusalem and the "Christian Holy Land" from Muslims which started the first crusade in 1096AD where Crusaders massacred Jews. Most of the Crusades were directed at Muslim states in the Middle East.

There were nine Crusades total, the last of which was in 1270. Because of the Crusades, Christianity's relationship with Islam was permanently changed and it continues to influence how the Middle East views the west even today.



"The Crusades were a crime against humanity, one for which apologies are due, especially to Muslims."

-Daniel Johnson

800 to 838 AD Leading up to the Crusades

What was going on in this time period? In the year 800AD Ambassadors of Caliph Harunu r-Rashid acknowledged the control of France over Christians living in Jerusalem. Also in this year, Jews living in Spain have "a golden age" of toleration under Muslim rule. Between 801 and 812, Vikings begin selling slaves to Muslims and in other parts of the world, paper money was introduced. In 813, Muslims attack the Civi Vecchia near Rome and they work at taking over Sicily from 827 to 831 when the succeeded in making the capital city of Palermo, their own capital. Conquest of the entire island of Sicily, however, would require seventy-five years of fighting.

The Battle of Pliska

The battle of Pliska took place on July 26, 0811AD in Pliska, the capital city of Bulgaria. This battle was between the Byzantine empire (Greek) and Bulgaria. The Byzantines were led by Nicephorus I and the Bulgarians were led by Krum. In 809AD Nicephorus sacked Pliska. This was not a major military attack but many settled in that area. In 811AD Nicephorus formed a large army of Anatolian soldiers. On July 25, the day before the battle took place, Nicephorus' troops marched unknowingly into a barricade set up by the Bulgarians in a river valley and were forced to stop there for the night. The next morning, July 26, Krum and his troops attacked the unprepared Byzantine camp. Most of the Byzantines died by fire when their camp was burned.

Because the Byzantine camp was set on fire during the battle of Pliska, it is likely that arrows were set on fire and shot at the camp of the Byzantines.

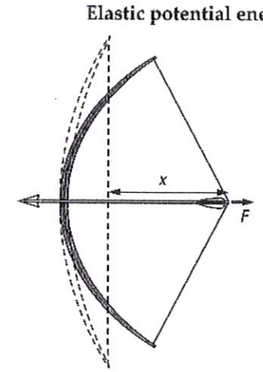
History of The Bow and Arrow

The use of bows and arrows for both hunting and war can be traced back to the Paleolithic period in Africa, Asia, and Europe. Arrowheads were first made of wood, then stone and bone, and then metals, but this was not a powerful weapon until the introduction of the compound or composite bow around 1500BC.

Physics

The arrow would be aimed at an upward angle rather than straight because of the fire, and would be pulled back into the string of the bow, building up potential energy. At this point the velocity of the arrow is zero. When the archer releases the arrow, it would continue in an upward direction at a constant horizontal velocity, until reaching it's peak height at which point it would be horizontal and the vertical velocity would be zero. Gravity is acting on the arrow throughout the entire trip but at this point the arrow begins to be dragged down by gravity. The path of the arrow would be in a parabola shape. Because the arrow was shot up rather than straight, it will take a longer time to reach the ground and will also go a shorter horizontal distance. The angle that it was shot upward originally is the same angle of the path of the arrow as it descends.

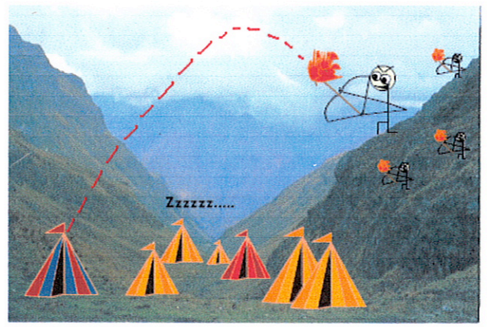
As gravity drags the arrow down to earth, the vertical velocity of the arrow will increase until it reaches it's destination. Because the tent crosses in the parabolic path, the arrow pierces the tent and sets the camp on fire.



In this picture, x is the distance that the arrow is pulled back on the string of the bow and F is the force pulling back the arrow (AKA the archer).

Picture Above: Crossbows were introduced to Europe around 900AD but were possibly used a few centuries earlier

Picture Below: Path of arrows shot at Byzantine Troops



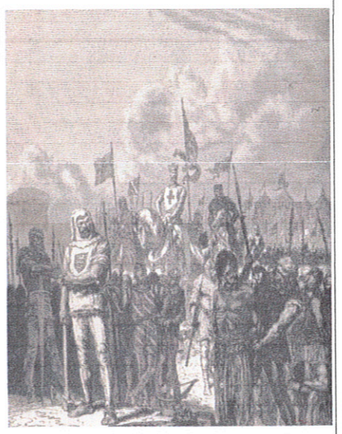
The Invasion of Rome 838 through 876

By Jonathan Jimenez and Ryan Glasheen

SARACENS VERSUS ROMANS

The Romans had no chance to win in the invasion of the Saracens because the Romans had no standing army except for untrained militia. The only weapons and armor the Romans used were a sword, armor and a helmet. This was all they could use against the Saracens.

The Saracens motive for attacking Rome was very obvious. Their motive was to invade for their own gain; more money and more land. The Romans were defeated by one devastating weapon. The Saracens used the javelin. The javelin had a sharp metal tip which was made out of wood or rock , it was easily carried around, and could be used as a melee weapon, but had a slow rate of fire. In a way the Saracens did have the advantage because the javelin could fire from a distance, and the swordsmen were cut down from far away. The Romans had no chance to get near the Saracens. The melee weapons just could not get close enough to inflict any damage. That was the utter downfall for the Romans.



Victory for the Saracens against the Romans

A Brief history

In the ninth century, many things happened, but nothing notable was recorded. There were many attacks from Africa, especially by the Arabs, and in these series of attacks there was the attack against Rome by the Saracens. Religion also grew fairly large. Christianity started spreading in places that it had not been before. Even the Nubians who where south of Egypt adopted Christianity, throwing away their old idols.

The Saracens came from North Africa. The Saracens were considered neither friends nor

enemies because they were nomadic and never became very close with other groups of people. If the Saracens ever found anything, they would take it for themselves. They were nomadic Arabs that would seek money or luxuries. The Saracens would plunder anything in a moment, just for their own gain. Even many of the finest trained Roman armies fled from the might of the Saracens. In this invasion of Rome, the Saracens, once again, showed no mercy, and the Romans lost their greatest city, Rome, in this battle.

Right now, the javelin is at rest. Its velocity is 0 meters per second and it has potential energy. The two are standing 50 meters away.

Currently the javelin is flying at 25 meters per second. The vertical potential energy is at its max and the vertical kinetic energy is decreasing, and the horizontal velocity is still the same as the initial. The horizontal kinetic energy, is the same as it was initially.

At this point, the horizontal and vertical velocities are both 0 meters per second. All of the energy has been transferred to knock over the swordsman, so it is gone from the javelin.

Origin of the Javelin

The javelin started out as a tool that allowed men in the prehistoric age to catch food. It was a simple rod of wood with a sharpened tip. It soon evolved into a weapon of war, but also a part of a game. The Olympics took in javelin throwing as a sport, and it rose quickly as a popular game. The Saracens used javelins that had sharpened metal tips, and a design that helped it fly more aerodynamically. However, the Saracens only used the javelin in war, not for games.
Javelin technology had also progressed. Back in prehistoric times, the javelin was essentially a stick that was sharpened badly at the end. In ancient Greek times, the javelin's tip was usually metal, or fine sharpened wood. The Saracens used a javelin that was deadlier, and even tipped it with poison for lasting effects.

A Saracen was trained with a javelin, and could usually throw it at speeds up to 25 meters per second.

The Parabola

The Javelin

The physics

The physics of a javelin are simple. There are only a few factors to throwing a javelin. When someone holds a javelin, ready to throw it, its velocity, both horizontally and vertically is 0 meters per second. It has potential energy. When the javelin is first thrown, the horizontal kinetic and potential energies are constant, the vertical potential energy increases, and the vertical kinetic energy decreases. When the javelin is at the midpoint of the flight path, the vertical velocity is 0 meters per second and the potential energy is at the maximum value. The kinetic energy in the vertical direction is 0 because it is not moving, and the horizontal velocity is still the same as the initial because there are no outside forces acting upon it. When the javelin starts coming down on the flight path, it accelerates at -9.81 m/s squared, and it loses potential energy to kinetic energy. Once again, the horizontal velocity is the same as the initial. When it finally hits the designated target, the horizontal and vertical velocity become 0 meters per second and the kinetic energy and potential energy are transferred to the target.

The Battle of Garigliano

By: Emily Cooper & Brody Evans

The Battle

The Crusaders fight against the Saracens

The battle of Garigliano was fought in 915 AD between the Christian League and the Saracens. The Christians were personally led by Pope John X and because of his influence he could recruit a large amount of people. The crusaders were victorious in taking a castle from the Saracen control thanks to their greater numbers. In August of 915, a force of Saracens was defeated by the Roman armies controlled by Pope John X, Duke Alberic I of Spoleto and Senator Theophylact. In 916, Pope John X organized a league of princes against the Saracens and finally defeated them in a great battle; routing them from their stronghold on the Garigliano River.

The Saracen Composite Bow

This is a diagram of the composite bow.

One of the Saracen's most used weapons was called the composite bow. Saracens used about 10,000 archers who would begin the battle by shooting arrows directly at the enemy. At the beginning, composite bows were not that common in battles, but, as time drew on, the Saracens continued to use archers in their armies.

The composite bow was about four feet in height and can fire the arrow about five times faster than the more common all-wooden bows that the Christians used.

Composite Bows were typically made of wood, horn and shredded animal sinew. They can pack the same power as a longbow but in a smaller, lighter form usable by a mounted archer. Composite Bows can usually be kept strung longer than other bows, for the sting will not snap since the material that makes the string is stronger and the bow is larger than regular wooden ones.

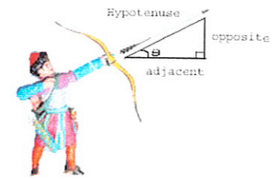
The arrows used for composite bows aren't any different from other arrows other than the fact that the materials used are from the Middle east or north Africa.

Tactics used with the composite bow tended to me more flexible and mobile than tactics used with the European archers. The people who used it were mostly horse archers who used the composite bow for hit and run guerilla tactics. The speed of the arrows and its shape was especially created for horseback archers. The Saracen bands that fought against the crusaders used the composite bows on horse back. Since most of the Islamic world at the time was nomadic the Islamic people usually fought on horseback because they were always on the move.

Bow Physics

The composite bow used many of the physics of projectile motion as do the other weapons of the crusades. The math and physics of the composite bow are as follows.

The arrow starts with an initial velocity of 0m/s. Then the arrow is fired. There is an angle, an opposite side, an adjacent and a hypotenuse side. There is also a horizontal velocity that will stay constant throughout the whole flight.



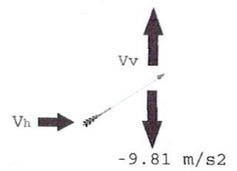
Picture of the arrow after it is fired from the bow

The horizontal and vertical velocities can be found using the following equations.

$V * Cos(\theta) = V_h$

$V * Sin(\theta) = V_v$

These factors will determine how fast the arrow flies through the air and how far away it lands. Throughout the flight the arrow will fly in a parabolic arc. When flying, the arrow will be decalerating in the vertical direction at a rate of -9.81 m/s^2 (gravity).



Picture of the velocity of a rising arrow

The arrow slows down and finally reaches the peak of the parabola. When the arrow reaches the peak the vertical velocity is 0m/s since the arrow has reached the top height. The arrow then starts returning to the ground at a rate of 9.81 m/s^2.

Picture of the arrow at the peak of the parabola.

To find the time it takes for the arrow to reach the ground use the acceleration formula $v_f = v_i + at$. To find the final distance multiply horizontal velocity by time. The equation is **d=rt**. The rate is the velocity and the time is the time of the total flight. This concludes the essay on the composite bow and all the physics used in a composite bow.

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The Bloody Battle of Brunanburh

riah Smith and Ariana Pientka 916-952 AD

What was going on?

Starting in 916 AD, was a somewhat span of years when Vikings were especially e and voracious, run- rampant, raiding any that was easily acces- by the coast. Their ns went unpunished in 925 AD, Athelstan declared the King of and. King Athelstan d a lot of power in a short time, and he patience with the Vi- and their barbaric

King Athelstan eeded to declare war e Vikings. This war me the Battle of Brunanburh, which ended with King Athelstn victorious and the Vikings embarrassingly defeated.

In 939, Athelstan's throne was taken over by his brother Edmund. The Vikings were stunned by their loss. They realized that although their plundering ways were central to their culture, the Vikings' dependence on raids and piracy for supplies would only get them so far. By 950, the Vikings have settled into a stable, permanent community in countries like Ireland and Scotland, and they have vowed never to raid anymore.

Above: This image is of a Viking in the time of the battle of Brunanburh.

The Battle

The Battle of Brunanburh was of the bloodiest and most impor- battles of its time. The battle was oked when the King of England, Athelstan, attacked Scotland and hclyde in 934 AD. Three years in 937, the kings of Scotland and hclyde joined forces with the Vi- King, Olaf Gothfrithson III. e Olaf had recently married the daughter of the Roman Emperor Constantine, the Roman empire was also dragged into the fight. The three kings and the emperor planned an attack on England, specifically on Athelstan, and proceeded to execute it within the year. The exact location of the Battle of Brunanburh is, even today, not known for certain, due to patchy historical records. The Battle of Brunanburh was long, and it was extremely brutal. Not even royalty was safe from its wrath—five British kings and seven Celtic earls were killed fighting in the Battle of Brunanburh. In the end, King Athelstan was miraculously victorious. King Athelstan's victory lead to the confirmation of England as an Anglo-Saxon kingdom.

The Javelin

A very commonly used weapon during the time of the Battle of Brunanburh was the javelin. A verse in an epic poem written to commemorate the Battle of Brunanburh states, "There lay many a man / Marr'd by the javelin."

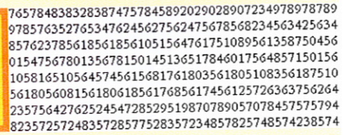
A javelin was a type of spear that was designed so its main use was to be thrown, not to be used in close combat. Thus, the javelin was lighter than the average spear, and was extremely streamlined to keep air resistance at an absolute minimum. However, the lightness came at a price: Javelins were not strong enough to withstand the blows of close combat for long.

Some ancient civilizations, like the Roman Empire, used this flaw to their advantage and designed their javelins to bend or break when they hit something hard, such as armor or a shield, so that the Romans' enemies could not reuse the javelins thrown at them. Javelins were lethal weapons in trained hands, because javelins could be thrown from a long distance away and still hit their marks.

Granted, javelins were harder to aim than a bow and arrow, since javelins were heavier than arrows, but a javelin moving at the same speed as an arrow would do more damage because it has more momentum and has more weight driving it forward. It was for this reason that javelins were a weapon of choice during the Battle of Brunanburh.

Above: A javelin as used in ancient times.

Math and Physics of the Javelin



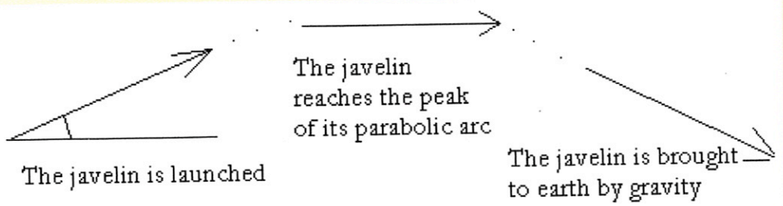
There is a fair amount of math and physics involved in a javelin. For example, a javelin has mass. This mass determines how much force a person needs to exert on the javelin to launch it. Force is calculated using the formula F=ma, or Force equals mass in kilograms times acceleration in meters per second squared. The more force that is used to launch the javelin, the harder the javelin is thrown, and the farther the javelin travels.

When the javelin is launched, it is always launched at an angle, because it would be impossible for a human to launch it perfectly horizontal. Thus, there is always a horizontal initial velocity and a vertical initial velocity.

The horizontal velocity will stay the same throughout the flight of the javelin, because there is nothing acting on the horizontal velocity. However, the vertical velocity will change because it is being affected by gravity.

The angle of launch can effect the distance the javelin travels. For example, let's say two javelins are launched with the same velocity. One javelin (javelin 1) is launched at a 30 degree angle and the other javelin (javelin 2) is launched at a 70 degree angle. The majority of the total velocity of javelin 1 is in the horizontal direction, whereas javelin 2 has most of its total velocity in the vertical direction. Javelin 2 may be in the air longer, but javelin 1 has a greater horizontal velocity. Javelin 1, therefore, goes farther, although its flight path is lower to the ground.

The motion of the javelin is what creates the parabolic arc: the vertical velocity at first is moving away from the Earth, but deceleration due to gravity acts on the javelin. Soon the pull of gravity cancels out the initial vertical velocity, creating a moment where the vertical velocity is zero. On a graph, this zero vertical velocity moment would be represented by the vertex of a parabola. Gravity then starts to accelerate the javelin's vertical velocity towards the Earth. The javelin stops when it hits either the ground or a person.



THE TREBUCHET

952-1028 A.D.

ed By: Anthony Wong
Matt McMahon

HISTORY OF THE TREBUCHET

There are two main types of trebuchets: a counterweight trebuchet and a traction trebuchet. The most commonly used trebuchets during the Middle Ages were the counterweight trebuchets because of their effective use during a siege.

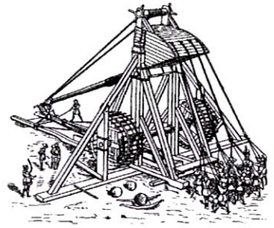
A counterweight trebuchet is powered by a falling counterweight, using the power of the counterweight to throw heavy objects over far distances. The trebuchet is at first 'winded' up so that there is potential energy that would be released from a lever and would have the counterweight pull down and throw the heavy object.

The most important part of the trebuchet is the arm, which must be light enough so that there is the most energy available but the beam cannot break. When designing a trebuchet, the designs had to be carefully thought-out. The execution of shooting the heavy payload was the most important aspect of the trebuchet.

The trebuchet itself was very heavy weighing many tons and could not shoot very fast. Smaller trebuchets would be able to fire a few times a minute. The payloads of the trebuchet were varied but mostly were large stones and boulders along with rotting bodies and livestock.

The normal range of a trebuchet was around 300 meters but advanced trebuchet plans were extremely well protected and lost through time. Many castle builders took the power of the trebuchet into the design of their castles and built large moats and artificial lakes to keep the devastating siege engine at bay.

Modern Trebuchet Design



Early Trebuchet

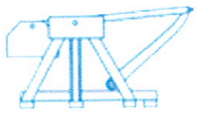
e Byzantine Empire is shown in orange

THE TREBUCHET LINE OF FIRE

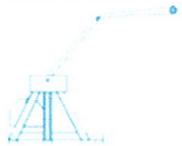
The trebuchet fires in a parabolic arc. This is one of the main reasons why the siege engine was so powerful. When the trebuchet arm is released, the counterweight would throw its payload up.

The payload could be dead livestock, enemy bodies, and Greek Fire. The most common payload that was thrown was usually a large stone or boulder.

Gravity is constantly acting upon the payload until the velocity of the payload reaches a peak. When the stone reaches the peak, the vertical velocity is zero. The horizontal velocity does not change because there are no opposing factors going against it. As gravity continually acts upon the stone, more and more velocity is gained until it hits the ground.



Trebuchet at rest



Counterweight is dropped

The Trebuchet's power could also be increased by making the counterweight fall straight down and adding wheels to the trebuchet so that the whole trebuchet itself would create and add its own momentum to the thrown object. It would vary from what payload you would be throwing and the mass of the payload.

Another variable would also include how heavy the counterweight is. The height and length of the trebuchet frame also affects how long the payload will stay in the air.

A larger and longer trebuchet frame would be able to throw objects much farther than normal. Adding wheels would also affect how long the payload would go as the momentum of the large frame moving would also increase the power of the payload.

How long the payload would be moving within the air would affect how far the payload itself would go. Another factor would also be how powerful the horizontal velocity would act on the payload.

Shot being fired

Trebuchet Ready for Siege

ANLGE OF THE TREBUCHET

Angle of the Trebuchet

The trebuchet has many angles in which the throwing 'arm', usually a wooden beam, would be able to shoot its payload.

However, the angle most likely used with trebuchets was at a -45 degree angle so they would be able to shoot off the payload in both horizontal and vertical directions. The counterweight also would fall straight down which would create the strongest possible force because there would be no other opposing forces on the payload except for gravity. This would allow the counterweight to achieve its full potential.

The initial angle and point where it is thrown is very important because it determines how far the trebuchet's payload would go and how long it would be in the air.

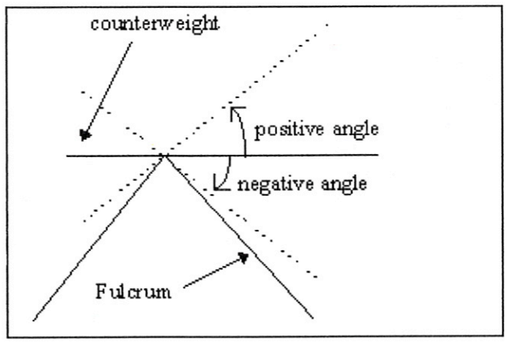
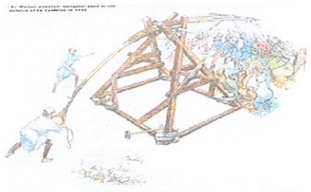


Diagram of Trebuchet Forces



Traction Trebuchet

Trebuchet at Chateau Des Baux, France

TIMELINE: 952-1028 AD

Byzantine Empire

During 952-1028 AD the Byzantine Empire was on the rise both economically and military wise with many successful conquering expeditions of lost lands.

Around 952 AD, The Holy Church of Hosios Loukas, or the Holy Luke, was founded in Greece by the Byzantines.

In 963 AD, The Great Lavra, or The Great Monastery, began construction on Mount Athos again in Greece and took 6 years to fully complete.

In 972 AD, a Byzantine princess named Theophano married the future king of Germany of the Middle Ages, King Otto the II, which improved the Byzantines' foreign relations.

A few years later in 976 AD, Emperor Basil II was crowned Emperor of the Byzantine Empire, and lead many successful expeditions defeating the Bulgars and was later nicknamed Boulgaroktomos or the Bulgar Slayer. Basil began his campaigns against the Bulgars every year from 1002-1018 AD. During this time the battle of Kleidion, which was a major defeat for the Bulgarians, occurred.

Out of the Bulgarian survivors, nine out of ten were blinded and this was a key moment of Basils' Bulgarian conquest when he gained the nickname: Boulgaroktomos. In 1018 AD, the Bulgarians finally surrendered and its territory was annexed to the Byzantine Empire.

The high point in the Byzantine Empire finally draws to a close as Basil II died and a decline begins with some ups but the Byzantine Empire finally drew to a close in 1025 AD.

Islamic Army

Islamic World

In 969, the Fatimids took over Egypt and founded Cairo which became the center of their 'empire'. Throughout the time period of 952-1028 over 10 rulers were established. In 999 AD, the Samanids' were disbanded after around a century of rule.

Magyars

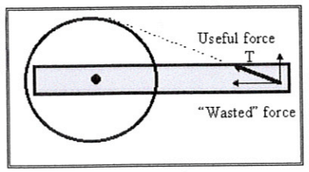
The Magyars were still unstable, mostly living in Austria when they were defeated by Otto I of Germany and go under German rule. Otto I made defeating the Magyars a top priority and in 955 AD, he defeated them at the battle of Lechfeld.

The Magyars were defeated so badly that they never went back into Germany and instead migrated into Hungry and settled there.

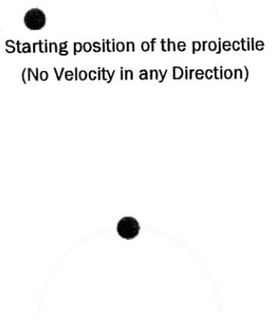
The Vikings

The Vikings raided all over Europe during this time, being pagans and worshipping many different gods. As the Vikings continued to raid, they begin to adapt to the idea of Christianity, even though the change came at different times because the Vikings lived in separate tribes away from each other. In 981 AD, Erik the Red discovered Greenland and was banished by his tribe from Iceland because he had wanted to explore. A few years later, the Vikings discovered Canada in 986 AD by the successors of Erik the Red.

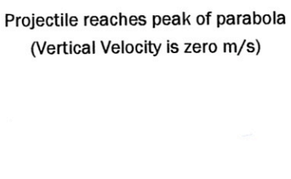
Viking Longboat



Trebuchet Throwing Arm



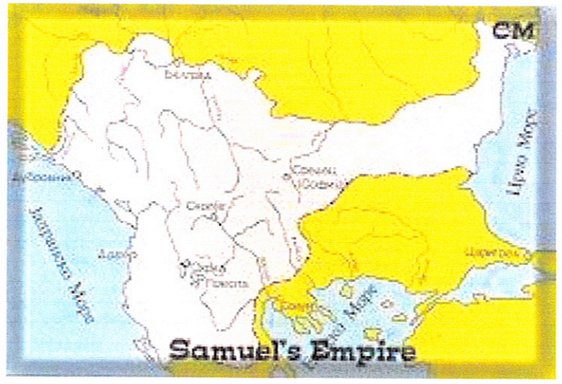
Starting position of the projectile
(No Velocity in any Direction)



Projectile reaches peak of parabola
(Vertical Velocity is zero m/s)

Projectile hits ground due to gravity's acceleration of 9.81 m/s²

Ancient Magyar Statue



Tsar Samuil's Empire of Bulgaria

Byzantine Warrior

BATLLE OF KLEIDION-BYZANTINES VS. BULGAIANS

Both the Byzantines and Bulgarians had been at war for the past few decades when the new tsar, Samuil of Bulgaria began to invade Byzantine territory. Basil II, Emperor of the Byzantine Empire wanted to stop Samuil and regain the land that the Byzantines had lost to the Bulgarians. After yearly conquests, Basil II had successfully regained all of the land lost from the Bulgarians and in 1014, Basil II army had finally met the Bulgarian army in full force.

Throughout the years of conquest, both sides were not able to meet each other in full force. The Bulgarians had learned that the Byzantines were arriving so tsar Samuil fortified the pass of Kleidion and set an entire garrison of 15-20,000 Bulgarians to defend Kleidion pass. When marching to Kleidion, the Byzantine army was harassed by Bulgarian raiders but was defeated easily when met in combat from a small force of Byzantines. After reaching Kleidion, Basil II besieged the defenses that the Bulgarians had set up. Even so, Basil II could not penetrate the strong defenses of the Bulgarians when one of his generals had gone around the pass and ambushed the Bulgarians on the other side with his army. When the Bulgarians' had their backs turned to the main Byzantine army, Basil II was able to penetrate and slaughter the Bulgarians. Out of the 14,000 prisoners that had been captured by Basil II, 13,860 were blinded (99/100; one was left to guide the men back to Samuil). There are different sources that say what happened after the battle. Some say that Samuil had died after seeing his troops while others say that he had survived the battle of Kleidion and died at a much later time. The battle of Kleidion was a key point in which the Byzantines had defeated the Bulgarians until the Bulgarians would become a province of the Byzantine Empire in 1018, four years later.

Kleidion Pass

Bulgarian Warrior

BY: STEVEN BAQUIAL & APRIL AGUIGAM

Duke William of Normandy's Conquest

During The Battle Of Hastings

1028-1070 AD

Battle of Hastings The Danish Battle Axe

Timeline

1035-1040 Harold Harefoot ruled England

1042-66 Edward the Confessor ruled England

1054: The patriarch of Constantinople and the Pope in Roma excommunicate each other (the Great Schism)

1057: End of the Macedonian dynasty

1059 AD – 1067 AD Constantine X (Dukas) ruled the Byzantine Empire

1064: The Seljuks invade Armenia

1066: (**Battle of Hastings**) Edward the Confessor dies, leaving no Saxon heir, the Norwegian Harald III invades northern England and is defeated at the battle of Stamford Bridge by King Harold, who is in turn defeated by William of Normandy, who thus ends the Anglo-Saxon rule of England and unites England and Normandy .

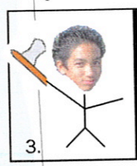
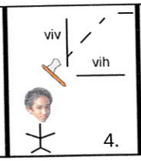
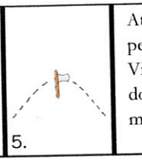
The Battle of Hastings was a huge event that happened during the time of 1028 AD-1070 AD. During this time, King Harold had taken throne of England. King Harold had a very short reign and during his reign, he was threatened by many conquerors. One of these conquerors was Harald Hardrada of Norway. Harald was a huge threat because he believed he should claim the throne instead of King Harold. On September 26th, 1066 AD Harald of Norway's victory forced King Harold to march his army north to defend his title. Harald Hardrada was killed and the remaining Norwegian army retreated and sailed back to Norway. King Harold's victory distracted him from his biggest threat, Duke William of Normandy (Figure one). Once William landed south of England to invade, King Harold learned he was going to be attacked. Harold then gathered his troops and traveled south to fight. King Harold moved to a place to set up his troops a few miles north of Hastings. Harold blocked William's only road out of the Hastings peninsula and forced him into a frontal attack. The battle took all day. Harold's troops were known as the Saxons and William's troops were known as the Normans. Harold built a shield wall to protect his army from the brutal fight. As the day went on both armies became tired and wanted to end the battle sooner. This forced William of Normandy to get his troops to shoot their arrows higher into the air to hopefully break the English wall. That day Duke William of Normandy and the Normans won the Battle of Hastings. On Christmas day of 1066 Duke William was crowned King of England. This battle was one of many that led to the Crusades. The Battle of Hastings was the last time England was successfully invaded and conquered throughout England's history of battles.

1. Duke William of Normandy

The Danish Battle Axe

The Danish Battle Axe (Figure two) was one of the weapons that the Saxons used during the Battle of Hastings on September 16th 1066. Before the Saxons, it was also a very common weapon for most of northern Europe and the Vikings. The Danish Battle Axe was a very large axe that had a sharp steel blade about thirty centimeters long. The blade was placed on a long wooden handle that was one meter long. During the Battle of Hastings King Harold and his soldiers used a five foot long handle on a twenty-five centimeter crescent blade. The axe usually weighed about four pounds and eleven ounces. The Saxons used it by either swinging it side to side or throwing it in the air. The axe was so strong and sharp that it chopped through a soldier on its horse in one slice. It also sliced through shields and helmets. The soldiers usually held the axe in both hands not able to hold a shield and protect them.

2. The Danish Battle

 3.	Steven is about to throw the axe across a 20 m distance.	 4.	The axe is thrown at 5 m/s. Viv=4 m/s Vih=3 m/s	 5.	At the peak the Viv slows down to 0 m/s.	It took 6.6 seconds to go across 20 meters.

The **path** of a projectile is a motion which is affected only by gravity. Every projectile has the same path. Usually when someone throws an object it has a path of a parabola (figure five), being exactly symmetrical. When the path is symmetrical, its half is an exact mirror view image which mean the height on the left side at the parabola is the exact same height of the right side of the parabola.

The **degree** that the object is thrown dramatically affects the path of the projectile. If thrown at a higher angle the path has a more narrow shape. If thrown at a lower angle the shape of the path is wider and shorter.

Distance of a projectile is the length in meters the object travels from start to finish. Certain things affect the distance that the object travels. Two examples are the rate and the time. If the object moves at a fast rate, it will go farther than if it were traveling at a slower rate. If the object was launched at a higher angle it would be a shorter distance as compared to a lower angle. If the object is thrown higher, it has a shorter distance because it has a higher vertical velocity than a horizontal velocity.

Gravity is acceleration due to gravity. The rate of gravity is always going to be 9.81 meters per second squared on Earth. Gravity always has an affect on the path of an air-bourn object. Usually if someone throws something in the air, such as a projectile, the object goes in a parabolic arc. Gravity causes the object to eventually fall to the ground. Gravity only affects the vertical velocity and not the horizontal because the horizontal velocity travels left to right.

Velocity is measured in meters per second. When an object is thrown in a projectile, it will have three different velocities. There is initial velocity which it is thrown, the initial horizontal velocity, and the initial vertical velocity (figure four). The horizontal velocity never changes unlike the vertical velocity. The vertical velocity changes due to gravity.

Time is measured in seconds. There are many things that affect the time of the projectile motion. One of these things is the rate of the object in the air. The rate of the object in the air is it's velocity in meters per second. If the initial vertical velocity was fast then the object would stay in the air longer. Another thing that affects the time is acceleration. The last thing that is affected by time is distance. This is true because in the formula distance equals rate times time, the change in distance will affect the length of time. For example, if an object is thrown over a farther distance, it would take longer for the object to land.

the Parabolic Motions of the First Crusade

History

1070-1104 A.D was a time period during the Crusades, a series of military campaigns during the time of Medieval England against the Muslims of the Middle East. The only crusade that happened between 1070 and 1104 was the First Crusade. The First Crusade was from 1076-1104. The event that led up to the first crusade was that the Muslims wanted Jerusalem and the Christians wanted it as well. The Muslims wanted to have Jerusalem as their own because Muhammad, the founder of Muslim faith, was in Jerusalem. The Dome of the Rock was in Jerusalem and it was built where Muhammad sat and prayed. It was so holy that no Muslim was allowed to touch it or tread on it

when visiting it. The Christians wanted Jerusalem because it was a holy place for them. Jesus was born near Bethlehem and he spent most of his life in Jerusalem. Jesus was crucified on Calvary Hill. Jerusalem was, to the Christians, the "City of God". Therefore, since the Muslims wanted to take Jerusalem away from the Christians, they attempted to capture the city. The battle ended with a Crusaders victory and Godfrey of Bouillon became the first King. The Crusaders wanted to get rid of the Muslims, so in 1104, the Battle of Harran began. In this battle, the Crusader States (Principality of Antioch) fought against the Seljuk Turks and the County of Edessa.

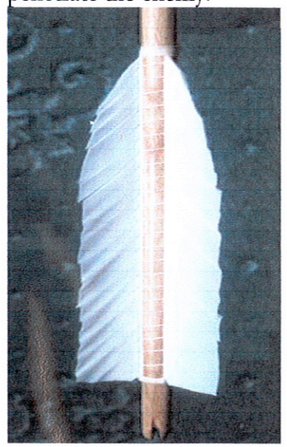
Before the First Crusade, there were smaller battles and events. In 1070, Jerusalem was conquered by the Seljuk Turks and taken from the Fatimids. Also in 1070, Brother Gerard began to organize the Order of the Knights of the Hospital of St. John of Jerusalem: a military force for the protection of Christian pilgrims. In 1080, the Order of Hospital of Saint John was founded in Italy. Then, in 1071, the Battle of Manzikert took place in Turkey. After that, the First Crusade happened and Jerusalem became the Seljuk Turk's and the Christians were prosecuted. In 1078, the Seljuk Turks captured Nicea. Throughout eight years of struggling to regain power, the Turks got control of Nicea in 1086 after it changed power three times. During the year of 1079, the Battle of Cabra was started where El Cid led his troops to a route of Emir Abd Allah of Granada. During 1081, Alexius I Comnenus became the emperor of the Byzantium and finally in 1084, Antioch fell to the Seljuk Turks. From there, the First Crusade was fought and the Crusaders became victorious.

The Battle of Manzikert

The Battle of Manzikert started in 1071. It was a battle between the Seljuk Turks and the Byzantine Empire and took place in Turkey. The leader of the Byzantine army was Romanus IV and the leader of the Seljuk Turks was Alp Arslan. The battle started on August 26, 1071 when the Byzantines marched towards the Seljuk Turks. The Turks were in a crescent formation, ready to fight and had archers who shot arrows at the Byzantine troops. The Seljuk Turks were organized and as the Byzantines got closer, the Turks surrounded them. After this, the Seljuk Turks got the perfect opportunity to capture Romanus and when they did, he was taken prisoner and the Byzantine army was defeated.

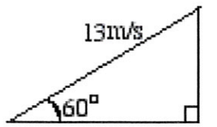
The Bow and Arrow

During the Battle of Manzikert, the Seljuk Turks used the bow and arrow as one of their weapons to fight the Byzantine army. The type of bow that the Turks used was a short bow, which has a wooden core, layered with sinews on the back and horn on the belly. It is glued together to increase the elasticity and strength of the bow. The arrows would have feathers on one end to stabilize it and a stone, bone or metal tip on the other end to improve how well it would penetrate the enemy.



Physics

An example of the parabolic motion of an arrow would be: If an archer shoots the bow at a 60° angle with an initial velocity of 13 m/s, the initial vertical velocity would be 11.3 m/s. Throughout the course of the arrow's flight, its horizontal velocity does not change because there are no forces acting in the horizontal direction; disregarding air resistance. Therefore, the horizontal velocity is a constant rate of 6.5 m/s. The vertical velocity, however, does change because the force of gravity acts in the vertical direction so it is affected by a constant acceleration of 9.81 m/s^2. How you find the initial vertical velocity is by using the equation: sin60=Viv/13. In other words, this equation is SOH (sin=opposite divided by the hypotenuse). In this case, the triangle that we formed in order to do this equation is:



$\sin 60 = Viv/13$

$13(\sin 60) = Viv$

$11.3\ m/s = Viv$

$13^2 = 11.3^2 + Vih^2$

$13^2 - 11.3^2 = Vih^2$

$\sqrt{41.31} = Vih$

$6.5 m/s = Vih$

Since it is a right triangle, you can use the Pythagorean Theorem to find the horizontal velocity after finding your vertical velocity.

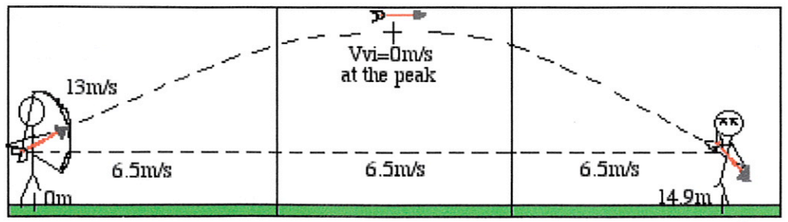
Vertical and Horizontal Velocities

At the peak of the arrow's flight, the vertical velocity is zero because a moving object has to come to a stop before going in the opposite direction. In the arrow's case, it begins by going up initial, and then when it hits its peak, it reverses directions and goes down. Since the arrow moves in a parabolic shape, the arrow has a vertical velocity of zero at its peak.

Angle and Distance

Keeping the same example, the total distance the arrow would travel would be 14.95 meters before it reached the same height at which it was shot. However, if the archer wanted to shoot an enemy that was further away and could only shoot at a velocity of 13 m/s, he would have to adjust the angle so it was smaller. Thus, the arrow would travel more in the horizontal direction than the vertical direction. Therefore, the angle of the arrow directly affects the distance which the arrow travels.

Meg Oka & Yvonne Byers



The Seljuk Turk archer shoots the arrow at a 60° angle. The arrow is shot at 13 m/s, therefore having an initial vertical velocity of 11.3 m/s and a horizontal velocity of 6.5 m/s.	At the arrow's peak, the arrow has a vertical velocity of 0 m/s because it comes to a stop before moving in the opposite direction. The horizontal velocity is still 6.5 m/s since there are no forces acting in the horizontal direction (disregarding air resistance).	The arrow falls and hits the Byzantine soldier that is 14.95 meters away from the Turkish archer. The arrow hits the enemy at the same height that the arrow was shot.

Sam Lewis & Emily Mekinna

Behind the Bow

The Battle

e of Ager San-
so known as the
Blood was a
d battle without
s. This battle
e year 1119, it
azi of Aleppo, vs.
Salerno.

Salerno was
ruling Antioch
wn as the princi-
Antioch which
ne was being
ed by the Byzan-
ire. Aleppo an-
ge city in Syria
der the control
abeg or governor
lghazi.

rst captured the
z which left
open to attack
usaders. Aleppo
aded the Princi-
f Antioch in 1119.

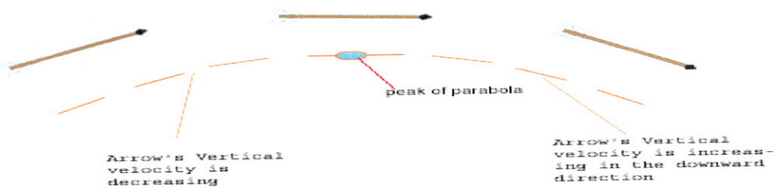
of waiting for
cements Roger
to attack Ilghazi,
azi's army sur-
d Roger's and al-
ompletely deci-
is army, only two
er's knights lived.
died in the battle
sword to the face
Ilghazi proved
ous.

The Bow

Many know of the Bow and arrow to be a simple weapon. Just aim and shoot right? …Wrong!

The bow and arrow was used for hundreds of years, several cultures such as the Egyptians, Saxons, Romans, Byzantines, used the bow until the 1400's when guns became the weapon of choice. There are several types of bows that have been invented throughout history the Longbow, the Recurve bow, the Composite bow, the Crossbow, and the Original bow, each one became more complex and accurate than its younger model.

The bow is a piece of wood curved, with a string taken from the gut of an animal. This weapon was most popular in times of war. Bows and arrows were used by placing the end of the arrow on the string, keeping it in place, but not attaching it. By pulling the arrow back with the string, aim at the target and let it loose. The arrow would then puncture the enemy with the sharp point, injuring or killing the enemy. (depending on what part of the body it hit.) Bows were incredibly deadly to infantry and cavalry. In the battle one side would have many archers, then they would fire volleys of arrows into the enemy lines killing the enemy's forces very quickly. The defending kingdom would then send out infantry and cavalry depending on how powerful their kingdom was to finish off the rest of their enemies.

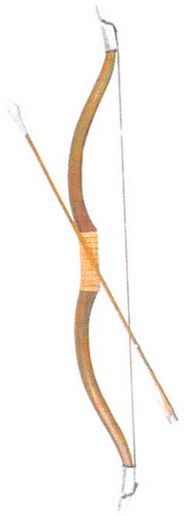


Parabola & Quadratics

Above there is a picture showing a parabola. This parabola which is warped by gravity. All parabolas have peaks, called the vertex . A parabola is also exactly the same on both sides so if you were to split the parabola down the center, where the peak is, both distances and times of the peak are the exact same. There are usually two parts to a parabola, the roots, and it's vertex. To solve a quadratic problem you must have the problem ether in vertex form $f(x)=a(x-h)^2+k$ or standard form

$f(x)=ax^2+bx+c$.

Vertex Form is to solve for the coordinates of the peak. The "a" in vertex form stands for how wide or narrow the parabola will be, "h" is the x coordinate of the peak, also being the horizontal direction. The "k" in the equation is the y coordinate of the peak, also the vertical direction.



Projectiles

Projectiles follow the path of a parabola and because of this we can calculate our velocities, rates, times, and distances. Like when the arrow leaves the bow it is immediately under the effect of gravity. The vertical velocity decreases until it is at the peak because of gravity. At the peak it's vertical velocity is 0. The gravity then affects it pulling it downs towards the ground. Increasing its vertical velocity except in the downward direction.

Meanwhile the horizontal velocity does not change because it has no forces acting on it. So it would be constantly moving at the same speed. That means if it were to go at five meters per second for ten seconds it would go fifty meters without any acceleration of any kind unlike vertical direction which has gravity affecting it.

When the projectile is shot or thrown it will always have an angle since it is physically impossible to shoot or throw at 0 degrees. With the velocity and the angle it is possible to calculate the vertical velocity and the horizontal velocity.

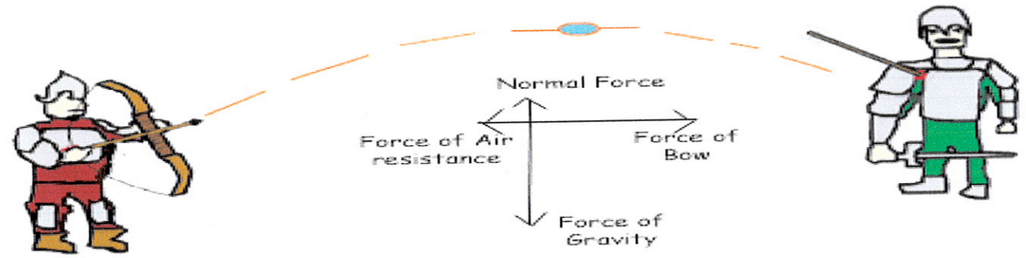
With Soh-Cah-Toa which is...

Soh: Sine equals opposite over hypotenuse.

Cah: Cosine equal adjacent over hypotenuse.

Toa: Tangent equal opposite over adjacent.

Each one of this equations can be used to find the vertical velocity, horizontal velocity, velocity or any of the angles.



This picture is showing the parabola and it is also showing a freefall graph showing the forces and how they affect the arrow.

Continued Quadratics & Parabolas

There is also the standard form which is

$f(x)=ax^2+bx+c$

The standard form solves for the y intercept but you can used to solve for multiple things consisting of finding your vertex, roots, and discriminate. The "a" in standard form is the also the same from the vertex form it stands for how narrow or wide the parabola is.

It all depends on roots having zero, one or two roots. Roots come from the quadratic formula.

$$\frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

Plug in your letters and then you can solve the quadratic formula to find your roots. Once the equation is solved there will be two answers, these answers are the roots of the problem.

Another way to find the roots is by completing the square which affects any real number. First thing to do in this method is to plug in the numbers into this equation

$x^2 + bx = f(y)$

The next step is to find half of "b" after that, take half of "b" and square that number and add it to both sides of the problem.

Solve for "y" and the answers are the roots.

Roxanne Beltran & Kristen Colley **Present :**

Catapults
&
The Second Crusade

1142-1180AD

Pictures.

Catapult.

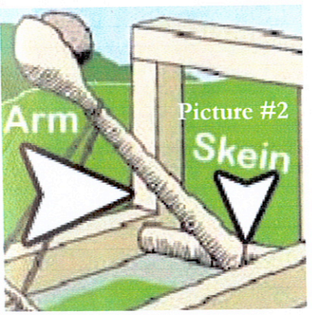
In 399 BC, the Greek, Dionysius, invented the catapult. The catapult gave warriors in the Second Crusade a way of beating down, piercing, or otherwise destroying part of an enemy's fortifications so as to gain entry. Catapults were used a lot in battle. Rocks, heavy materials, and burning material were flung at the enemy.

Catapults are able to launch things quite a distance – the average distance being 500 to 1,000 feet (150 to 300 meters). The catapult works by storing energy in the skein (picture 2). Then all of the energy releases at once, throwing the projectile.

Warriors were looking for a way to improve the catapult, and they came up with gunpowder and cannons. When gunpowder was developed, the use of the catapult decreased. Without the catapult, gunpowder and cannons would never have been invented. The modern day catapult is based upon designs derived from the ancient Greeks. The only difference is that the modern day catapult, or trebuchet, is more efficient, accurate, and powerful. This is because people are able to use material that were not available in early 400 BC. Nowadays, the catapult is used for education, competition, and on aircraft carriers.

Picture #1

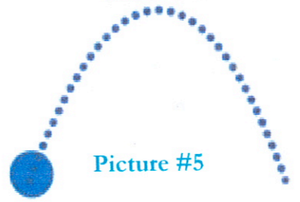
Math & Physics.



Picture #2

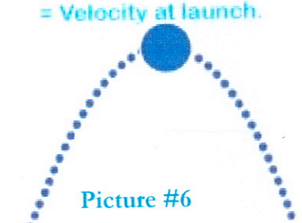
In lowering the arm, energy is stored in the twisted bundle of rope [skein], and when released, the arm is flung forwards (picture 2). The force contained in the skein is at its greatest when the arm first starts to move, and at its least when it hits a padded buffer, which acts as a stopper. This allows the projectile to leave the sling at maximum speed before halting. There are three main points of a projectile's path: the starting point, the peak, and the ending point. At the starting point, the projectile is flung from the catapult with a vertical (Vv) and horizontal (Vh) velocity. From the beginning of an objects flight, gravity is affecting its vertical velocity. Gravity slows it down enough to the point where at the object's peak, its vertical velocity is 0m/s. If there was no gravity, then the projectile would never come back down to earth. At the end point, where the object hits the ground, it

Object in first stage, before launch. ViV and ViH are 0.



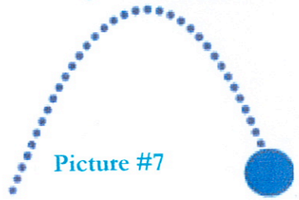
Picture #5

Object in second stage, at peak, ViV = 0, and ViV = Velocity at launch.



Picture #6

Object in final stage, at end, ViV = 0, and ViV = 0. Projectile Stopped.



Picture #7

"Regardless of the fact that the battle was ill-advised, they fought it anyways and suffered a miserable defeat while the Muslims were victorious."

- KMC & RSB

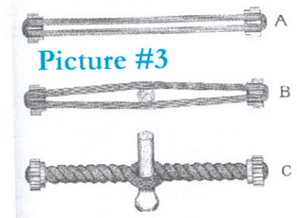
Math and Physics [Continued].

oses most of its velocity.

The path of a projectile looks like a parabola, an upside down U. This is because the object is being thrown upwards and outward. (pictures 5-7). The object is affected by gravity, which forces it to come back down to the ground again.

There are many things that affect the length of the time that the object is in the air. The first and most obvious is gravity, because if there was no gravity, the projectile would stay in the air forever. The initial velocity affects the time because the faster the projectile is launched vertically; the longer it stays in the air. In addition, air resistance is a key factor in how long a projectile will stay in the air. For example, if you drop a feather and a bowling ball from the same height, the bowling ball will hit the ground faster because it has less air resistance than the feather. How far the object goes depends not only on how long the object is in the air, but the initial horizontal velocity as well.

If the projectile is launched at a 90 degree angle from the ground, the object will go straight up [if there is no wind] then there will be no horizontal distance traveled. If the projectile is launched at 45 degrees, the object will go farther than it did when being shot up at 90 degree angle.



Picture #3

The Second Crusade.

Ever since 1130 AD, Imad ad-Din Zengi's (Zengi) main goal / job was to expand his rule southward while also keeping his northern borders secure. Zengi was the atabeg (governor) of Mosul. He knew that Edessa, one of the four crusader states, was having frequent combat with the Turks, and that they were in a very vulnerable position. In December of 1144 AD, Zengi and Muslims under his command attacked the city of Edessa. After four weeks of being under siege, Edessa fell and Zengi was able to completely take control of it.

Picture #4

A year after this, in December of 1145 AD, Pope Eugenius III sent out notices to everyone in his empire, telling them to fight and initiate the Second Crusade. He also ordered Saint Bernard of Clairvaux to travel all throughout Europe, and tell people to "take up the cross" and preach the Second Crusade.

The Second Crusade was the first crusade that had European kings fight in it. In 1148, the Second Crusade arrived in Syria, led by Louis VII of France and Conrad III of Germany. They decided to attack the city of Damascus, despite the former alliance they had made with the Kingdom of Jerusalem. Regardless of the fact that the battle was ill-advised, they fought it anyways and suffered a miserable defeat while the Muslims were victorious. The Second Crusade was one of the shortest, the battle lasting only from 1147—1149AD.

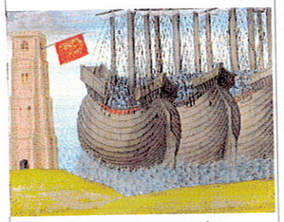
The Children's Crusade

1180– 1218 AD

Heather Medlin and
Teissa Barling

The Children's Crusade

dren's Crusade is given to a variational and factual 1212 AD that some or all of ments: visions by ildren marching Italy, an attempt he Holy Land, dren being sold ery. In the sum- 212, a 12 year old es Stephen of vas approached gar who said he or crusader re- from Palestine. was being gener- gave him a piece of bread crust and then the beggar revealed himself to be Jesus Christ. He handed Stephen a letter and told him to give it to the King telling him to



lead the next crusade. Stephen had convinced 15,000– 30,000 children (no older than 12 years old) to travel with the knights down to the Mediterranean. Chronicler, Alberic of Troisfontaines recounts, that two wealthy merchants Hugo Ferreus and William Porcus, offered free passage to the Crusaders. They got seven boats together, crammed them to the rafters with children, and everyone was off. After the boats disappeared from sight, nobody heard from them for eighteen years. There was obviously someone that returned to tell the story.

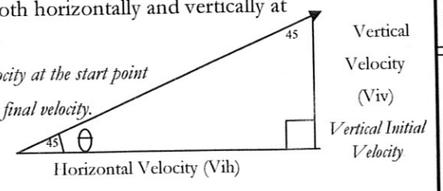
The Spear

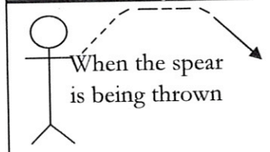
ear was a common used for hunting and nsisting of a handle, usuvood, with a sharpened he head may be the ed end of the handle s is the case with bamears, or it may be of anaterial fastened to the shaft. The most common design is of a metal spearhead, shaped somewhat like a dagger. The spear is the most common weapon that our ancestors used during hunting and war. They were also used a lot for fishing. In the Children's Crusade the spear was used as a weapon, it was not anything like a gun or a cannon. It was a weapon that the crusaders were able to hold or throw. It was thrown when there was an enemy far away and they did not want to get to close, because they could get injured or killed.

Velocity: a vector quantity whose magnitude is a body's speed and whose direction is the body's direction of motion. The horizontal velocity is the velocity in the horizontal direction. The vertical velocity is the velocity in the vertical direction. When the spear if thrown, it travels both horizontally and vertically at an angle.

Initial: velocity at the start point

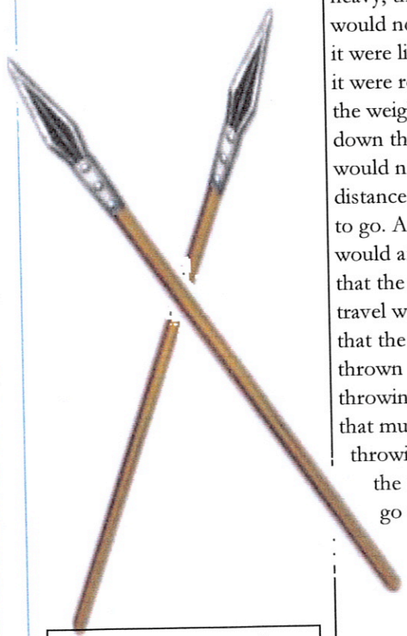
Finial: the final velocity.





Distance: d= rt

Like in time there are several things that can affect distance. One being mass. If the mass of the spear was big and heavy, then the spear would not go as far as if it were like a baseball. If it were really heavy then the weight would weigh down the spear and it would not go the full distance it was intended to go. Another thing that would affect the distance that the spear would travel would be the force that the spear is being thrown at. If the person throwing did not put that much force into throwing the spear then the spear would not go as far as if they were trying to beat a world record.



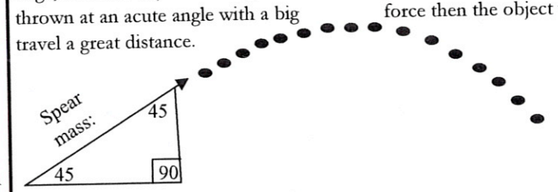
The spears above are similar to the spears that were used in the crusades.

Gravity: a force that tends to pull things to the center of the earth. Gravity would affect the path of the spear because if there were no gravity the spear along with everything else would not come down to Earth, they would just drift off to space. The gravity helps the spear by letting it go a certain distance in a certain amount of time. On the surface of the Earth, acceleration due to gravity does not change. It is measured at 9.81 m/s^2.

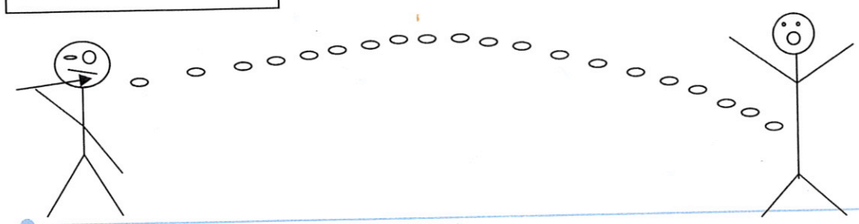
Time: t=d/v t: time d: distance v: velocity

There are several things that can affect the length in time that the spear is being thrown. One being mass. Because if the mass of the spear was extravagant then the spear would not go as far if it were as light as a baseball. Another thing that would affect the length of time would be the force that was being used to throw the spear. If there were a little bit of force put into the spear then it would not go very far. It might go merely a distance of 6ft. If there were a lot of force put into the spear being thrown then it would go much farther, most likely around 40-50ft. If it were to go farther then it would take longer depending on the force put in. Also it depends on the angle or the direction the spear was being thrown. If the spear was being thrown facing down then it would take a shorter amount of time to travel. Sometimes weather can affect the time it would take for the spear to travel, if there was wind and the person that was throwing the spear threw the spear against the wind, the wind would slow down the time it would take for the spear to travel.

The **angle** that the spear is thrown at affects the vertical and horizontal distance. If the spear is thrown at an acute angle then it would have a great distance as to when it is thrown at and obtuse angle it would have great height. BUT it always depends on the force that the spear is being thrown, because if there is greater force the spear would more likely go farther. When something is thrown at an obtuse angle and the force is large, then the object would go further and higher. When an object is thrown at an acute angle with a big force then the object would travel a great distance.



The circles represent the path that the spear goes in.



CONNOR POHLING

MARC ATRASH

THE BALLISTA

The Crusades (1218-1256 AD)

Gravity

Math & Physics Involved

There are many different math and physics concepts involved with the ballista and a projectile as it follows the path of a parabola. Some of these concepts are velocity, gravity, projectile motion, and acceleration.

Velocity

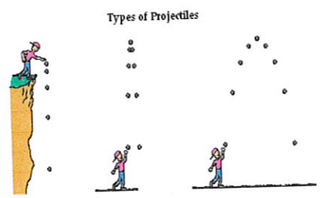
Velocity is defined as a vector quantity whose magnitude is a body's speed and whose direction is the body's direction of motion. In the ballista, velocity can be found throughout the flight of the arrow. When working with projectile motion velocity is split into two different parts, vertical and horizontal. Horizontal velocity remains the same, but since vertical velocity is affected by gravity, it is always changing.

Gravity is the force that acts upon everything on Earth. Gravity is involved with the ballista because gravity effects everything, including the ballista. On Earth acceleration due to gravity is 9.81 meters per second squared. So when the arrow heads up gravity acts against it, but while the arrow heads downward gravity accelerates it.

Projectile

A projectile is an object upon which the only force acting on it is gravity. In this case the arrow moves in a parabola. In the picture below, a parabola is 2 and 3.

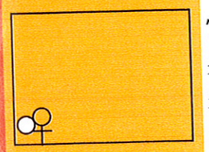
1. 2. 3.



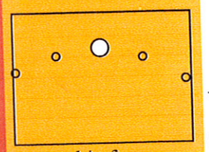
Time

In the Ballista time is effected by many different factors; the first would be gravity. Without gravity the arrow would keep flying forever and ever and the time would be infinite. Another factor would be the initial velocity of the arrow, if the arrow was launched faster, the distance and the time would be much greater. Last is the angle that the arrow is launched. If the arrow is launched towards the ground the time will be much shorter than if it was launched straight up.

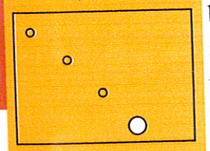
Parabolic Arch



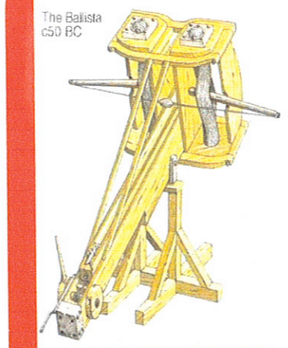
In this frame, the projectile (rock), has no velocity



In this frame, the projectile has reached the peak, where Vv=0.



In this frame, the projectile comes to a stop, it now has no velocity



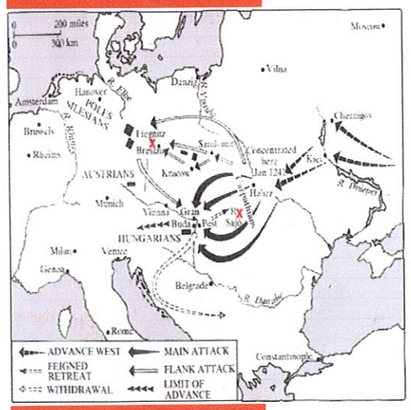
This is a Ballista used in ancient times

History of the Ballista

The Ballista is a powerful ancient weapon, similar to a giant cross-bow, which ejects heavy arrows or stone projectiles of various sizes.

The early Ballista was based off a weapon called the Gastraphetes. The Gastraphetes was a handheld bow possessing enormous power in comparison to similar weapons of the time. The problem with the Gastraphetes was that the force it generated to shoot an arrow forward also created the same amount of force backwards, so it would knock the user backwards. So to use the power of the Gastraphetes, the solution was to mount the weapon on the ground. This was the first form of the Ballista.

The Ballista was used as a siege weapon, it was positioned on the edge of a battlefield and was used to throw both stone and arrow projectiles. The stone projectiles could cause huge amounts of damage to city walls, and the arrows could kill several men at once.



A map of the Mongolian invasion in Hungary in 1241 AD

History of the Battle

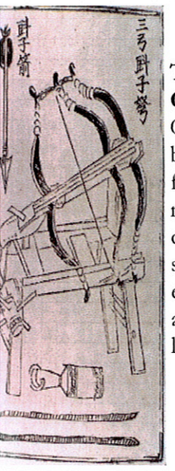
In 1241 the Mongolians marched into southern Hungary because the Mongolians wanted to punish Bela, the King of Hungry. The Mongolians wanted to punish Bela because he put 200,000 Cumans into an asylum in 1238. This attack was lead by General Kadan. Later a second line attacked central Hungry; this attack was lead by Batu and Subetai. Bela's army found Batu's camp near the Thesis and the Sayo Rivers. They were then surrounded by Batu's army and were defeated. The Mongolians used a Ballista, a large cross bow and a large catapult. The Ballista was used to kill the enemies from far away instead of hand to hand combat. The usage of the ballista help the Mongolians defeat Batu's army.

By: Joe Rubio and Sarah Ramlaoui

The Battles of 1256-1299

ttle of Stirling Bridge
me: September 11, 1297

he Battle of Stirling was between the ots led by William Wallace and the nglish led by the Earl of Surrey. Ed- ard the first was leading the Earl of rrey. After hearing that his up com- g daughter-in-law, Margaret, daugh- r of King Alexander, died, Edward as forced to choose an heir for the rone. Edward choose someone he ew he could manipulate, and oose Balliol, and began to manipu- ting him whenever he wanted. Bal- ol soon noticed what was going on, d did not wait to rebel, and allied th France. Edward marched north d took Balliol prisoner. During this me, Edward was occupying Scot- nd, and the Scottish were not happy th that. William Wallace was one of e angry Scots, and brought a large oup of men to retaliate. The Earl of rrey marched to the Stirling bridge nly to find Wallace's army waiting gerly for them. The bridge was not ry wide, and only allowed two peo- e to cross at a time. Wallace took is to his advantage, and cut the Earl f Surrey in half. As a result, William allace claimed victory over the Bat- e of Stirling, and was knighted and ut into command of the Scottish army.



The Chinese Crossbow: The Chinese crossbow was deadly from over 365 meters. The crossbow was shot like a modern hand gun, and was easy to learn how to use.

Battle of Falkirk
Time: 1297-1298

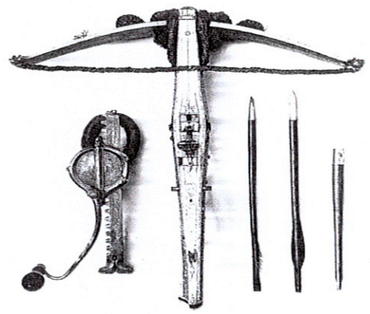
William Wallace brought an army together at New Castle. Edward the first, "hammer of the Scots", was determined to bring Wallace's rebellion down. William Wallace soon advanced his party ahead to the Earl of Surrey. Wallace had been waiting in Falkirk and had gathered only half as many men that he had before. Most of these men were only armed with spears, backed with cavalry made up of a large majority of nobles. They were led by Sir John Comyn, "Black Comyn". It was not until July 22nd that the real battle began. Wallace did not have much luck in battle. His men on horseback ended up leaving the area. Edward and Surrey had gotten back on Wallace for Stirling Bridge. Wallace stepped down from being guardian of Scotland. Yet, he still asked Scotland for military support.

Number of men on each side:
-William Wallace was able to amass 30,000 men to pick up arms and fight for the liberation of Scotland.
-Edward was able to organize a massive army of 90,000

Who Invented the crossbow: The Greeks were one of the first to begin using the crossbow. It was first called gastraphetes or "belly weapon" because the person had to brace the curved centre-piece of the butt end against his chest or stomach.

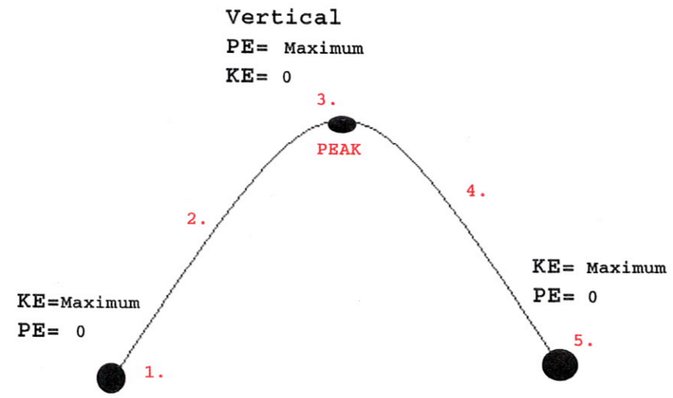
Willaim Wallace

William Wallace: William Wallace was one of Scotland's greatest heroes of his time. He struggle's to free Scotland from England's rule in the end of the 13th century.



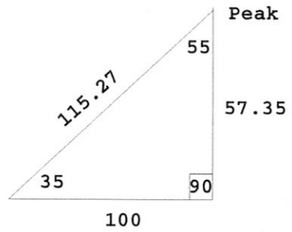
German Crossbow:
Weapons mainly used in the battle were spears, axes, swords, javelins and most importantly crossbows. Much like a gun, crossbows would be fired with a trigger. They were able to fire up to 400 meters away at velocities of 40.5 meters per second. The only weakness of crossbows was the fact that they had a very slow rate of fire.

Physics of The Crossbow

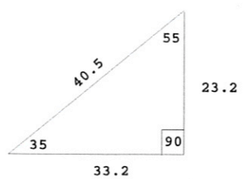


The arrow is shot at 40.5 meters per second. The potential energy slowly climbs as the arrow's elevation rises. As told the equation for potential energy is mass x gravity x height. As the height rises the number will get bigger, since the mass and gravity don't change. Also, as the height of the arrow increases gravity causes the arrow to lose vertical velocity. The horizontal velocity remains the same because there is no force to affect the horizontal velocity.

Finding Lengths



Finding Velocities



1. sin35= x/40.5
23.22

2. $x^2 + 23.2^2 = 40.5^2$
33.2

Sin35=opp/100
57.35= opp
HEIGHT= 57.35

$57.35^2 + 100^2 = C^2$
115.27=C

KE- KE stands for Kinetic Energy. The equation for KE is $1/2mv^2$. KE is energy that is being used, for motion. KE can convert to PE

PE- PE stands for potential energy. The equation for PE is mgh. PE can turn to KE which can be used to move the object.

Acceleration- Acceleration is the change in velocity that happens over time. That is why acceleration is velocity/time or distance over time squared.

Velocity- Velocity is distance/time.

Point one:
The arrow has not been launched. The velocity of the arrow is zero, and it has no gravitational potential energy. The vertical velocity and how far the arrow goes greatly depends on the angle that it is shot at.

Point 2:
The arrow is shot at 40.5 meters per second. The potential energy slowly climbs as the elevation of the arrow rises. Also, as the elevation of the arrow rises gravity causes the arrow to lose vertical velocity. The horizontal velocity of the arrow remains the same throughout the whole motion.

Point 3:
The arrow's vertical velocity is at zero. The arrow's potential energy is at maximum and the horizontal velocity remains the same. This point is also better known as the vertex.

Point 4:
The arrow's horizontal velocity is the same still. The vertical velocity rapidly increases because of gravity. The potential energy that was reached at the peak becomes kinetic energy.

Point 5:
The arrow's horizontal velocity is the same and the vertical velocity is at its fastest point before the stop. When it hits the person, it no longer has potential energy and all the kinetic energy has been transferred from the arrow to the person.

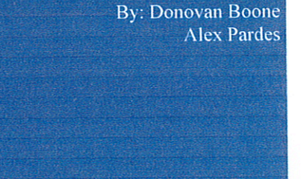
By: Donovan Boone
Alex Pardes

The Longbow

Two armies fighting in the First Crusade.

The Crusades (1294-1332 AD)

The Crusades had ended after the Muslims captured Acre, the last Christian city in the Kingdom of Jerusalem in 1291. After more than 200 years of occupation, the crusaders had finally lost all of their control over the Middle East. After the Crusades, Europe was changed forever. The Crusades coincided with a growth of European population and commercial activity. They provided an opportunity for expansion to the growing population. But most importantly, they offered rich trade opportunities in spices and silks to the merchants of the growing cities of the West; Genoa, Pisa, and Venice. After the crusades the Turkish had taken over almost all of the Byzantine Empire and the Christians feared the Muslims greatly because of the Muslims power. William Wallace, the defender of Scotland, won the battle of Stirling and ended the Age of Chivalry by defeating the English army with the use of pike men to impale the horses from below. After the victory William Wallace lost the Battle of Lanark, which led to his execution at the start of the 14th Century. Robert the Bruce led Scotland to final victory and freedom in the Battle of Bannockburn. Edward I was the king of England from 1272-1307. He returned from the Ninth Crusade in 1294 and was crowned king. William Wallace of Scotland began a series of attacks against England in an attempt to secure Scotland's freedom. King Edward was still hungry for battle after the Crusades, and he launched an attack against Scotland. He came to Scotland with an army of almost 20,000 soldiers. Many of them were well equipped veterans. When his force met the Scottish, the Battle of Falkirk began.



The attack routes of the first Crusade.

The Battle of Falkirk

William Wallace had recruited a force of about 30,000 soldiers from the peasants who idolized him. With these men he moved to Falkirk where he fortified his position and prepared for Edward's attack. Wallace burned all of the fields near Falkirk to prevent Edward's army from being resupplied. Edward's army was hungry and demoralized. Many of Edward's men left. and parts of the army began fighting with each other. On July 21, 1298, Wallace led his small force towards the larger English army. The next day the two armies were within sight of each other, and the battle began. During the battle one night Wallace was planning to attack Edward's army because he had heard there was a lot of trouble going on over there because of the lack of food and lack of sleep. Then two traitors from Wallace's army told Edward of the whereabouts of Wallace's army and how Wallace planed to attack that night. This betrayal led to the certain defeat of Wallace. After Wallace's nighttime raid was foiled, Edward's army easily crushed the Scottish peasants. This battle proved the longbow to be extremely effective. Edward's army launched wave after wave of arrows that led to the quick defeat of the Scottish.

Math

A projectile often moves horizontally as it moves upward and/or downward.

A ball going in an parabolic arc. Which is also called projectile motion.

What affects how far an arrow will go?
When the arrow is fired from the bow it is given an initial velocity. This initial velocity would remain constant and the arrow would travel forever if no other forces acted on it, as stated by Newton's first law of motion. But as soon as an arrow is shot on Earth, air resistance and gravity start to act on it. Air resistance acts in the opposite direction the arrow is traveling, and reduces the arrow's speed. Gravity pulls the arrow towards the Earth, and increases the arrow's vertical velocity in the negative direction.

How does gravity affect the path of the arrow?
Without gravity an arrow would travel in a straight line, but gravity causes acceleration, so the path of the arrow becomes a parabola. On Earth at sea level, gravity causes all objects to accelerate at a rate of $-9.81\ m/s^2$. If the arrow is shot upwards, the arrow will travel upwards initially, but once the arrow reaches it's peak The arrow will accelerate in the negative direction until it comes to a stop.

A drawing of the battle of Falkirk. It also shows the longbow being used in this battle. (See page 29 for a more detailed description of the Battle of Falkirk.)

How does the initial launch angle affect the path of the object?
By changing the initial launch angle of the arrow, you can completely change the path it travels along. If the arrow is shot straight up in the air, disregarding the effects of wind, the arrow will not move horizontally at all. The arrow will travel the furthest horizontally if shot upwards at a forty-five degree angle. It will travel less far the further the angle is from forty-five degrees.

What affects the length of time the arrow is in the air?
The amount of time the arrow is in the air is affected by the initial vertical velocity of the arrow and the amount of acceleration there is due to gravity. On Earth the acceleration due to gravity remains fairly constant, so the main variable that affects the length of time the arrow is in the air is the initial vertical velocity of the arrow. The higher the velocity is, the longer the arrow will stay in the air.

This is a welsh longbow. The welsh longbow is usually made out o of yew, maple or oak.

The Longbow

The Welsh longbow had been known during the Welsh Campaign of 1282 to be an effective weapon. The longbow was light, portable, inexpensive to manufacture and powerful. A longbow was about six feet long. The length of the bow gave greater leverage to the arrow where as the crossbow depended upon extreme tension of the string to propel the dart and consequently took a longer time to draw. The longbow had a maximum range of 400 meters. The longbow had a metal tip and could easily pierce chain mail. The bow was made out of yew, maple or oak. A trained bowman could shoot one arrow every five seconds or about twelve per minute. This rate of fire was a clear advantage over the crossbow.