An Introduction to Rocket Flight

Learning Objective	In this lesson the student will learn the origins of rocket flight and will be introduced to some of the key individuals whose discoveries brought us to where we are today.
Grade Level	5 – 8

– Introduction –

Saturn V

Modern rocket flight is the culmination of centuries of discoveries and experiments. From early discoveries in Alexandria to the work of Sir Isaac Newton and up to Wernher Von Braun, rocket flight has changed our world significantly.

Through the use of rocket flight we have been able to put

satellites in orbit. This has allowed us not only the ability to map our world, but have enabled us to connect to each other in ways previous generations could only dream off. For example, GPS satellite have changed our world like few other technologies have.

Rockets have allowed humankind the ability to send spacecraft to explore the planets we share the solar system with. In the 1960s, American astronauts were sent to the moon to explore. Their spacecraft and lunar lander were both carried to the moon using the massive Saturn V rocket. More recently NASA has successfully landed a rover on Mars that conducts experiments and sends data back to earth.

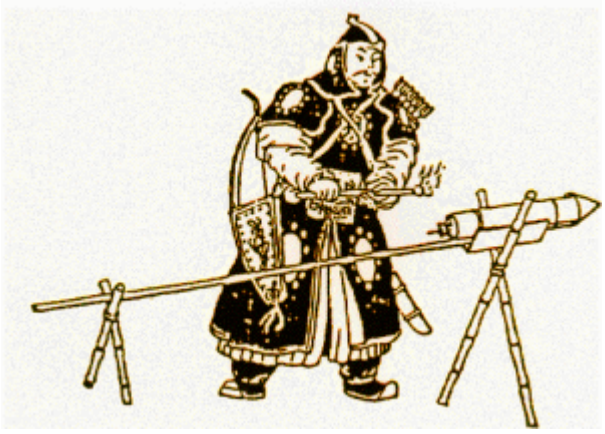
A Brief History of Rockets video

We will start the lesson off with a video on a brief history of rocket flight. The video starts with the early discoveries and leads through to the private space industry. We will then expand on some of the concepts later in the lesson.

Early Discoveries

The main principles behind rocket and jet motors can be traced back to the Hero Steam Engine. Invented by Hero of Alexandria in the early years of the first millennium, the Hero Steam Engine was a sphere filled with water and when heat was applied, spun on its axis as the steam escaped.

Hero of Alexandria, also known as Heron of Alexandria, was a Greek mathematician and engineer born in the ancient city of Alexandria of Roman Egypt. He was highly influential in his time and his work is representative of the Hellenistic scientific tradition.



Rockets using gunpowder were invented by the Chinese sometime

around 1232 A.D. These early rockets were developed as weapons and possibly used by the Chinese against Mongol hordes. The devastation caused by these early rockets could be heard for 25 km (15 miles) with a destructive radius capacity of 600 metres (2000 ft).

Galileo Galilei, born in Italy in 1564, was known for many accomplishments including reigniting the flame of scientific discovery. His Hellenistic beliefs, the belief that the Earth and planets revolved around the Sun, were quite controversial at the time. He spent the last nine years of his life under house arrest where he continued to publish works promoting Heliocentrism.

Sir Isaac Newton and the Laws of Motion

Sir Isaac Newton
image: NASA

Sir Isaac Newton was born in England on Christmas day in 1642. He was a physicist and mathematician and is considered one of the most influential scientists of all time.

During the Black Plague of the mid-1660s, Cambridge University, where young Isaac Newton was a student, closed its doors for two

years. During his time away from the university, Newton worked on his theories which would form the basis of his 1687 book, Philosophiæ Naturalis Principia Mathematica ("Mathematical Principles of Natural Philosophy").

Often referred to as Principia, this book is regarded by many as the most important work in the history of science.

During his life, Newton also made contributions to the field of optics, and he shares credit with Gottfried Leibniz for the development of calculus.

Newton's Three Laws of Motion

Described in Principia, Newton's three laws of motion are:

- Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it.
- The relationship between an object's mass m its acceleration a, and the applied force F is F =ma
- For every action there is an equal and opposite reaction

Robert Goddard – The Father of Modern Rocketry

Robert Goddard
image: NASA

As electric power came to American cities in the 1880s, a young boy by the name of Robert Goddard started his life-long interest in science and technology. As a five-year-old, he was fascinated by static electricity generated from the family's carpet. To further the young Robert's scientific interests, his father provided him with a microscope, a telescope, and a subscription to Scientific American. Goddard would go on to become the man many considered to be the "Father of Modern Rocketry."

Dreaming of Space Travel

As a teenager science fiction took hold of Robert's imagination. This combined with his interest in technology resulted in his preoccupation with flight. The date of October 19th holds special significance for Robert Goddard. On this day in 1899, while pruning the family's cherry tree, he experienced an epiphany of sorts. Not only did he think that it was possible to go to Mars one day, he came up with an idea of how to bring that about. On this day he realized his purpose in life, and observed its anniversary every year after that.

University Research

Goddard began to make a name for himself while doing his undergraduate degree at Worcester Polytechnic. In 1907 a powder rocket was fired in his lab in the basement of the institute. This garnered much interest in his work. He continued his post-graduate studies at Clark University and not long after earning his PhD, he accepted a research fellowship at Princeton.

In 1913 Goddard came down with tuberculosis and while doctors did not think he would survive, his research gave him the energy to pull through. Once he was better, he applied for two patents to protect his intellectual property. One was for liquid-fueled rockets, the other for multi-stage rockets.

Smithsonian Support

In 1920, Robert Goddard's paper "A Method of Reaching Extreme Altitudes" was published by the Smithsonian Institute, who provided him (among others) with financial support for his research. The paper outlined the theories of rocket propulsion. It also mentioned the possibility of a rocket reaching the moon. This was negatively received and ridiculed by reporters, instilling in Goddard a life-long distrust of the public media.

First Liquid Propelled Rocket Flight

On March 16, 1926, Robert Goddard tested the first rocket using liquid fuel in Auburn, Massachusetts. The 2.5 second flight saw the rocket rise 41 feet. This demonstrated that liquid-fueled rockets were a possibility. NASA describes this event to be as important as that of the Wright Brothers at Kitty Hawk.

In 1936 the Smithsonian published "Liquid Propellant Rocket Development," the contents of which would become a precursor to the technical innovation of the V2 missile.

Wernher von Braun

Wernher von Braun (right) with Walt Disney
image: NASA

Born in 1912 in Wirsitz, in what was then the German Empire and now Poland, von Braun's aristocratic background gave him an upper middle class upbringing. The second of three boys, he became proficient in playing the cello and piano at an early age and for a while wanted to become a composer. At 13 years of age, a gift of a telescope from his mother sparked a life-long interest in astronomy.

It was also at this time that von Braun discovered the book *By Rocket into Interplanetary Space* by rocket pioneer Hermann Oberth. He was able to experiment and apply what he read of Oberth's book when he joined the Society for Space Travel at 18 years of age.

Despite not doing well in his early academic life, his devotion to aerospace resulted in an undergraduate degree in aeronautical engineering (from Berlin Institute of Technology) and a

doctorate in physics (from Frederick William University). Not only did Oberth's book inspire von Braun, he described it to be the guiding light of his life.

V-2

While von Braun was working on his doctorate in the early 1930s he caught the attention of the Nazi Party. The Nazi Party had made rocketry a part of the national agenda and all civilian rocketry activity was banned. As rocketry became part of the national agenda, von Braun had virtually limitless access to create and test rockets. It was during this time that the V-2 rocket, a liquid-propellant rocket and ballistic missile, was created by von Braun and his team and deployed by Nazi Germany. To this day the extent of von Braun's role in the Nazi Party, his motivations and intent, are inconclusive. It has been noted, however, that space travel was first and foremost von Braun's goal. Whatever the case may be, the V-2 design is the precursor to all modern rockets.

Going to the Moon

The post-war era proved to be a frustrating time for von Braun. After surrendering himself and his team of rocket scientists to the Americans in 1945, they were expected to develop missile technology for the US Army—the Redstone rocket being a result coming out of this period. The army was not interested in von Braun's vision of space travel at this time. Meanwhile the Soviet Union was developing new rocket designs and launching Sputnik.

By the late 1950's America started to get anxious about the apparently emerging Space Race and so created NASA in 1958. In 1960, NASA's Marshall Space Flight Centre was established in Huntsville, Alabama and von Braun was asked to be the director. He accepted on the terms that he could continue to work on the

Saturn rocket (program).

The Saturn rocket would eventually lead to the Apollo program, culminating in sending three men to the moon in 1969.

Father of Rocket Science

Not long after this momentous event, von Braun retired from NASA as it became evident that interest and funding in space flight dramatically dropped.

After NASA, von Braun worked for the aerospace firm Fairchild Industries, continued to give speeches at universities and promote space camps for children. He also helped to start the National Space Institute (currently the National Space Society) and in 1977 was awarded the 1975 National Medal of Science by the U.S. government.

The Cold War between the Soviet Union and the United States following the Second World War brought about the race into space between the two nations. Sputnik 1 launched by the Soviet Union became the world’s first artificial satellite. Human flights into space followed, which lead to moon landing in 1969. The massive Saturn V rocket was the vehicle to do the job.

Space Shuttle and the Future

NASA’s space shuttle first flew in 1981 and would continue until 2011. The space shuttle was made up of a glider style orbiter with liquid fuel propelled rocket motors. Fuel for the motors was provided through the large tank the orbiter was attached to. Large solid fuel rocket boosters at the sides of the tank provided much of the initial power for the space shuttle.

In 2003 China became the third country to send humans into

space. The Chinese Shenzhou spacecraft, based on the Russian Soyuz, is launched into space aboard China’s Long March rocket.

With the retirement of the space shuttle program, focus has now been placed on private firms to build and launch rockets into space. With a goal of improving the efficiency, we may be looking to a future of more frequent rocket flights into space.