National Curriculum Learning Pack

Space Race
The Space Race

The Space Race was a competition between the USA and the USSR to explore space using artificial satellites and manned spacecraft. It can be seen as a part of the larger arms race, as developments in space research could easily be transferred to military research. Both countries started work on developing reconnaissance satellites well before the height of the Space Race. The Vostok spacecraft used by the USSR to put Yuri Gagarin into space, for example, was developed from the Zenit spy satellites used by the Soviet military.

However, the military benefits of the Space Race were not the only driving force behind the American and Soviet attempts to explore space. The populations of both countries took a great interest in their respective space programs and it was a useful way for both superpowers to demonstrate their superiority. Nikita Khruschev, the Premier of the Soviet Union, used the country’s early success in the Space Race to claim that the “economy, science, culture and the creative genius of people in all areas of life develop better and faster under communism.” The American President John F. Kennedy, on the other hand, is quoted as saying “Everything we do ought to…be tied in to getting on to the Moon ahead of the Russians…we hope to beat the USSR to demonstrate that instead of being behind by a couple of years, by God, we passed them.”

In America the space program was headed by the National Aeronautics and Space Administration, or NASA, who were given control of all non military activity in Space. The team at NASA included Dr. Wernher von Braun, the German scientist responsible for the development of the V2 rocket during the Second World War. He was later moved to the United States by the U.S. Army to study the future potential of rockets and masterminded the development of the Saturn V Moon Rocket.

Figure 1: A V2 Rocket

Early Russian research was also based upon the German’s V2 rocket and involved members of Von Braun’s production team under the supervision of Russia’s Chief Designer, Sergey Korolyov. There was no equivalent of NASA in Russia, however, and this, along with the USSR’s economic disadvantage, would prove detrimental to continued Soviet success in the race to the Moon.
NASA

On 5 October 1957 the Soviet Union succeeded in putting the first man made object into orbit around the Earth. This Satellite was called Sputnik. It was followed a month later by Sputnik II, which carried the first space traveller, Laika the dog. Their launch caused a huge shock all around the world, but especially in the United States, where people had grown used to their countries technological superiority.

In response to Sputnik and Sputnik II, the United States launched the Vanguard test satellite in December 1957. Whereas the Sputnik launches had been a great success, the televised Vanguard launch was a spectacular failure, leading to newspaper headlines such as ‘Flopnik’ and ‘Kaputnik’.

The US Navy's Vanguard rocket rose just over a metre before sinking back down towards the launch pad and exploding when its fuel tanks ruptured. Sputnik had orbited the Earth for more than two months at a height of about 250km, transmitting a regular radio beep back to Earth. The Vanguard test satellite, on the other hand, was thrown clear when the launch vehicle exploded, landing on the ground a short distance away with its transmitters still sending out its own radio signal.

Despite the successful launch of Vanguard 1 in March 1958, there was still a fear of the Soviets gaining the upper hand in space. Later that year the National Aeronautics and Space Administration, or NASA, was created and given control of all non military activity in Space.
NASA took control of the Vanguard programme and went on to launch Project Mercury, which ran from 1959 to 1963. The Mercury programme was designed to discover if man could survive in space and to put a man into orbit. However, the Americans were again beaten by the Soviet Union, when Yuri Gagarin became the first man to orbit the Earth in April 1961. It was not until almost a year later, in February 1962, that John Glen became the first American to enter Earth’s orbit.

Project Mercury was followed by Project Gemini and Project Apollo, both of which focussed on landing a man on the moon. Project Gemini was used to conduct various experiments in space and to work out some of the finer details relating to a manned moon mission. Gemini established that longer duration space flight was possible and also demonstrated that it was possible for two vehicles to rendezvous and dock in space.

These successes fed directly into the Apollo programme, with its aim of landing a man on the moon and returning them safely back to Earth. It was only at this point, during the late 1960s that NASA pulled away from the Soviet space programme, leaping ahead of the USSR by landing Neil Armstrong and Buzz Aldrin on the moon in July 1969.

The Mercury Programme

NASA’s Mercury space program ran from 1959 to 1963 and cost a total of $1.5 billion. Its aims were to determine if man could survive in space and to put a man into orbit around the Earth. However, as early as 1961 the Russians had pulled ahead of America’s space program, having launched two men into orbit, Yuri Gagarin and Gherman Titov.

The first American to go into space was Alan Shepherd who successfully made a sub-orbital flight in May 1961. During this flight Shepherd took manual control of the spacecraft to test its controls and also made observations of conditions outside. Unlike in Russian missions, where cosmonauts parachuted from their spacecraft during landing, the Mercury spacecraft had their own parachutes to slow them down during descent. This made Shepherd the first man to return to Earth with his ship, Freedom 7, which landed in the North Atlantic Ocean, on May 5th.
Despite this success the pressure was still on to send an American into orbit, but before risking the life of an astronaut NASA wanted to ensure the safety of its spacecraft for an orbital flight. Therefore, in November 1961, Enos the Chimpanzee orbited the Earth twice before splashing-down, alive and well, off the Puerto Rican coast. Just three months later, in February 1962, John Glenn became the first American to orbit the Earth in Friendship 7. During his flight Glenn experienced various difficulties, including a problem with Friendship 7’s controls. He also reported seeing ‘fireflies’, although these were probably small ice crystals being vented from onboard the spacecraft.

Each of the manned Mercury missions were named by their pilots, seven military test pilots who had been picked from a group of 110 men. These names always included the number 7 to acknowledge the teamwork of the first ever astronauts, although only six of these men actually flew as part of the Mercury Programme.

The seventh Mercury astronaut was Deke Slayton, whose Delta 7 spacecraft was supposed to have completed America’s second orbital flight in May 1962. Before the mission went ahead, Slayton was diagnosed with an irregular heart beat and replaced by the astronaut Scott Carpenter. Although stripped of his flight status, Slayton went on to play a key role in later NASA programs as head of the Astronaut Office. He was responsible for selecting the crews for all NASA’s missions between 1963 and 1972, including the selection of Neil Armstrong and Buzz Aldrin for their trip to the Moon. Slayton was later re-instated as a pilot, flying on the Apollo-Soyuz Test Project during the 1970s.

**Project Gemini**

The Gemini space program was originally seen as a simple extension of project Mercury. It was designed to develop techniques for more advanced space travel, paving the way to Project Apollo and its objective of landing a man on the moon.

The main objectives of the Gemini program were to observe the effects of long duration space flights on astronauts, to establish rendezvous and
docking techniques between vehicles, and to perfect the method of landing spacecraft at a pre-selected point. The project was announced in December 1961 and ran until 1966. The total cost was $5.4 billion.

The word Gemini means ‘twins’ in Latin and each of the Gemini spacecraft were designed to carry two astronauts. As a result the Gemini spacecraft were larger than those that had been used in Project Mercury. The earlier Mercury capsules had been very small. They were filled with a huge number of switches, fuses and levers, meaning they were only just large enough to carry a single crewman. The Gemini capsules, on the other hand, managed to free up some space by placing many systems, such as life-support, in a separate section of the craft. The Gemini spacecraft were also designed to be able to change their own orbit meaning that they would be able to carry out rendezvous and docking procedures with other vehicles. To help them with this the spacecraft had their own onboard computer.

The astronauts for Gemini were made up of veterans from the Mercury program and 13 new recruits. The selection of crews was the responsibility of Deke Slayton who gave the original Mercury astronauts the first choice of missions. However, the crews were often re-arranged by Slayton to ensure the best combination of astronauts and each mission now had both a primary and a backup crew.

The Gemini project was a great success and led to many important milestones in America’s space program. For example, on June 03rd 1965, Ed White became the first American to carry out a space walk. White spent over 15 minutes performing manoeuvrability experiments outside Gemini 4, using a nitrogen powered gun.

This Extra-vehicular activity (EVA) had not actually been planned as part of the original mission. However, when Aleksei Leonov became the first man to carry out an EVA in March 1965, the Americans were keen to show that they were not falling further behind the Soviets. By the final Gemini mission, Gemini 12, NASA had proved that space walks could be carried out both easily and efficiently, with Buzz Aldrin performing three EVA’s over the course of three days.

Gemini did encounter a few problems, however, such as those experienced by David Scott and Neil Armstrong on Gemini 8. The astronauts had to
abandon the mission just 10 hours into their flight when the spacecraft began to roll at a rate of one revolution per second. This problem was caused when one of the spacecraft’s thrusters became stuck, but Armstrong was able to stop the spinning by using the capsule’s reentry control thrusters and performing the first emergency landing of a manned U.S. spacecraft. Despite the disappointment of the mission, it had shown that Armstrong was able to maintain a cool head during emergency situations and this proved critical in his later selection for Apollo 11.

Project Apollo

Project Apollo ran from 1961 to 1972 and was originally designed to carry out a series of manned missions which would orbit the Earth. However, in May 1961 the American President, John F. Kennedy, made his famous speech to congress. In this speech he announced his desire to land a man on the Moon by the end of the decade and to return him safely to Earth.

This announcement led to a major change in direction for the Apollo program, which would now be responsible for realising Kennedy’s dream. It was only at this point that the Gemini space program was announced, with its own goal of developing techniques for the moon landings. The Gemini program was not completed until 1966, with the first manned Apollo mission planned for early in 1967. Things did not get off to a good start.

On 27th January 1967 the crew of Apollo 1 were killed during a training exercise. This was caused by an electrical spark somewhere in the Apollo capsule’s 31 miles of wiring. Thanks to the Oxygen rich atmosphere of the capsule, the fire spread very quickly and within just 17 seconds all three astronauts on board were dead, including Gus Grissom, one of the original Mercury 7. The accident led to a complete redesign of the Apollo capsule, including changing the atmosphere to an oxygen / nitrogen mixture, just like the atmosphere on Earth.

The delays the accident caused meant that the next manned mission, Apollo 7, was not launched until October 1968, giving NASA just over a year to reach the lunar surface before the end of the decade. Before the year was out Apollo 8 became the first manned capsule to orbit the moon, with the crew spending Christmas in space. This mission saw a number of important firsts for the space program. It was the first time astronauts had passed through Van Allen’s radiation belts and the first time man had witnessed an earthrise. Perhaps most importantly, however, the astronaut Jim Lovell was able to confirm that there is a Santa Claus from his unique vantage point of the Earth on Christmas Day 1968.

By the summer of 1969 NASA were ready to attempt a moon landing when, on July 16th, Apollo 11 was launched carrying Neil Armstrong, Michael Collins and Buzz Aldrin. Once again, the mission did not go as smoothly as planned. During their descent to the Moon the Lunar Module’s (LM) guidance computer was leading the crew towards a large crater, surrounded by a field of rocks. Armstrong had to take manual control of the LM and was able to guide it to a safe landing site with just 15 seconds of fuel left. Despite such problems the
mission was a success and on July 21st Neil Armstrong and Buzz Aldrin became the first men to set foot on the Moon.

Figure 5: Buzz Aldrin on the Lunar surface (NASA)

Apollo 11 was followed by five further successful moon landings, between November 1969 and December 1972. Each mission carried out a variety of scientific tasks on the lunar surface and overall the program returned almost 400kg of rocks and other materials to Earth. All of these samples have helped to provide a better understanding of the Moon, but perhaps the most important of these is the Genesis rock which was found by the crew of Apollo 15. The rock is a sample of lunar crust that was formed billions of years ago during the very early stages of the Solar system.

The Apollo program came to an end in 1972 when Eugene Cernan, the commander of Apollo 17, became the last man to walk on the Moon. Further missions had been planned, but were cancelled to make extra money available for the Skylab program and the development of the space shuttle, the next generation of American spacecraft.

The Soviet space program

In August 1957 the Soviet Union carried out the first successful test of the R7 Semyorka, the world’s first Intercontinental Ballistic Missile (ICB). The R7 was the culmination of research and development based upon the Nazi party’s V2 rockets, which had been launched at Allied nations during the Second World War. The first of these, the R1, was a replica of the V2, built by German prisoners under the guidance of Sergey Korolyov. Korolyov was a rocket engineer who was soon able to improve the original German design. The R2 was able to travel twice as far as the R1 and by the time of the R7, the rockets had an almost global range, making them the ideal choice for a space launch vehicle. The Space Race had begun.

Just two months after the Semyorka had been tested, Korolyov succeeded in putting the first man made object into orbit around the Earth. This Satellite was called Sputnik. It was followed a month later by Sputnik II, which carried the first
space traveller, Laika the dog. Their launch was a major propaganda success over the United States and soon Korolyov was charged with building upon the Soviet Union’s achievements in space.

Figure 6: The Sputnik satellite (NASA)

Planning for a manned mission began in 1958 and resulted in the Vostok program, which ran from 1960 to 1963. The program was a great success and in April 1961 Yuri Gagarin became the first man to orbit the Earth aboard Vostok 1. He was joined by five fellow cosmonauts over the next 2 years, including, Valentina Tereshkova, the first woman in space. The Vostok programme was followed by the Voskhod programme, which saw the Soviets achieving further milestones. The most important of these was achieved by the crew of Voshkod 2, when Aleksei Leonov performed the first ever space walk on March 18th 1965.

Korolyov’s next target was to try and land a man on the moon before the United States. To achieve this goal he had designed the N1 rocket in conjunction with staff at his OKB-1 design bureau, as well as working on the design for the Soyuz manned spacecraft. Then, in January 1966, Korolyov died from a heart attack during a routine operation. It was only at this point that the world learnt the identity of the Russian's Chief Designer. His identity had been kept secret during the 1950s and 1960s, but he was now buried with state honours in the Kremlin Wall Necropolis.

Responsibility for landing a man on the moon now passed to Korolyov’s second in command, Vasily Mishin, who approved the launch of Soyuz 1 in 1967. The spacecraft crashed, killing the cosmonaut Vladimir Komarov. Further problems were experienced when each of the unmanned N1 test flights exploded. These setbacks saw America pull ahead of the Soviets in the space race and on July 21st 1969 Neil Armstrong and Buzz Aldrin successfully landed on the moon. Although plans for a Russian mission continued into the 1970s, the program was eventually cancelled in 1974.

The Vostok Programme

The Vostok programme ran from 1960 to 1963 and aimed to send a man into space for the very first time. This goal was achieved on 12th April 1961 when Yuri Gagarin became the first man to orbit planet Earth. Gagarin had been
chosen from a group of 20 cosmonauts selected for the Soviet space program. His backup for the mission was Gherman Titov, who went on to become the second man in space aboard Vostok 2.

![Image of Yuri Gagarin](image)

Figure 7: Yuri Gagarin (NASA)

The spacecraft used for the programme had originally been designed as spy satellites for the Soviet military and were therefore very cramped inside. They were made up of two separate sections, the descent module and the instrument module. These were designed to separate upon re-entry, with the descent module bringing the crew safely back into Earth’s atmosphere. Unlike American spacecraft, which descended to Earth with their crew onboard, Soviet cosmonauts ejected from their capsules at about 23,000 ft, using their own parachutes to land separately.

Gagarin’s flight lasted less than two hours, but was another great success for the Soviet Union. During his stay in space Gagarin was promoted to the rank of Major and became an instant celebrity upon his return to Earth. However, his historic flight did not pass by without its problems. Upon re-entry the two sections of the spacecraft had failed to separate properly causing the spacecraft to gyrate alarmingly. This worrying situation continued for 10 minutes until the bundle of wires connecting the two sections burnt through, releasing the descent module.

Many Soviet officials did not expect Gagarin to return alive and some conspiracy theorists believe that there may have been previous attempts to send a Russian into space which ended with the deaths of the cosmonauts involved. Gagarin’s own spacecraft included enough provisions for a 10 day mission just in case the retrofire engines failed and Gagarin was left to wait for his orbit to decay naturally. However, the retrofire engines worked perfectly and 1 hour, 48 minutes after launch Gagarin ejected from Vostok 1, landing safely in a farmer’s field in Russia’s Saratov region.

Four months later, in August 1961, Gherman Titov piloted Vostok 2 into space for over a day to test the effects of weightlessness on the human body. As he passed over America Titov broadcast a ‘hello’ message to the American people, who would not send a man into space until the following year.
Despite experiencing similar re-entry problems to Gagarin’s mission, Vostok 2 was followed by 4 further missions, culminating in Vostok 6 in June 1963. Seven further flights had been planned, but were later incorporated into the Voshkod programme, with its own goal of achieving yet more Soviet ‘firsts’ in space.

The Voskhod Programme

The Voskhod programme was the Soviet Union’s second human spaceflight project and developed out of the earlier Vostok programme. Only two manned flights were made as part of the project which aimed to achieve Soviet milestones in space, particularly the launch of the first multi-person crew. This was achieved by Voskhod 1, which became the first spaceflight to carry more than one person into orbit, beating the American’s Gemini programme to yet another first. However, the Voskhod programme is best remembered for the flight of Voskhod 2, when Aleksei Leonov became the first man to carry out a spacewalk or EVA (Extra-Vehicular Activity).

The spacecraft used as part of the Voskhod programme were heavily based upon the earlier Vostok variety. However, the ejection seat was removed to make way for two more cosmonauts and a solid fuel retrorocket was added to the descent module. This booster provided a smoother landing for the descent module which would now carry the crew all the way back to Earth. Further changes were made to the Voskhod spacecraft for Leonov’s historic mission, namely the inclusion of the Volga inflatable airlock. This was only extended once Voskhod 2 was in orbit and it was discarded once Leonov was back inside the spacecraft. It was controlled from inside the Voskhod capsule by the mission’s commander, Pavel Belyayev.

Leonov’s historic spacewalk lasted less than 12 minutes, but it was long enough to beat the Americans to yet another first in space. It had taken the cosmonaut 18 months of intense training to prepare for the EVA for which he wore a special backpack, supplying him with oxygen. However, his mission very nearly ended in disaster when his space suit inflated in the vacuum of space, making it very difficult for him to move. This meant that Leonov was unable to take any photographs of his spacecraft and was also unable to recover the camera that had been filming his spacewalk. By far the most alarming problem, however, was the realisation that Leonov could no longer fit inside the inflatable airlock. The cosmonaut had actually been given a suicide pill for use in just such an event, but was able to solve the problem by venting some of the suit’s pressure and squeezing back into the spacecraft.
Voskhod 2 was the final mission in the Voskhod program. A change of leadership in Russia saw the focus of the space program shift towards the moon. Leonov’s ability to maintain a cool head during emergency situations had been noted and in 1968 he was selected to command a circumlunar flight. However, with the success of Apollo 8, which successfully orbited the moon in December 1968, this flight was cancelled. Leonov was switched to another important mission, the attempt to land a Soviet cosmonaut on the moon.

The Soyuz Programme

The Soyuz spacecraft was designed as part of the Soviet Union’s attempts to land a cosmonaut on the Moon. The programme can be traced back to the early 1960s, although the first launch of an unmanned Soyuz capsule did not take place until 1966, after the successes of the Vostok and Voskhod programmes. It was in this year that two separate cosmonaut training groups were created. One of these, led by Aleksei Leonov, would train towards the landing mission, whilst the other would learn how to control the Soyuz spacecraft. This second group was led by Colonel Vladimir Mikhailovich Komarov.

Komarov himself was selected for the first manned launch of a Soyuz capsule and on April 23rd 1967 Soyuz 1 blasted off from Russia’s Baikonur Cosmodrome. During its flight the spacecraft experienced problems with its automatic stabilisation system and orientation detectors, whilst a faulty solar panel also caused power shortages. Despite these problems it should have been possible to return Colonel Komarov safely to Earth, but after the spacecraft’s main parachute failed to open, Soyuz 1 crashed at a speed of nearly 400mph, killing the cosmonaut on impact.

Before attempting another manned mission the Russians carried out a series of unmanned launches, using Soyuz capsules, as part of the Zond program. The first of these, Zond 4, was launched in March 1968. This was followed by Zond 5 in September 1968 which carried the first animals, a group of turtles, on a return flight around the Moon. The success of this flight was followed a month later by the launch of Soyuz 3 with Georgi Beregovoi on board. Further manned launches in both 1968 and 1969 tested key elements of the proposed
moon landing, cosmonauts for the mission were selected, including Aleksei Leonov, but the 18 month delay had seriously hindered Soviet progress.

Further problems were encountered with the N1, the massive rocket designed by Sergei Korolyov to send Soviet cosmonauts to the Moon. The first of these was tested on February 21st 1969, but exploded just 69 seconds after lift off. This was followed by three further test flights, all of which ended in disaster. The worst of these occurred on July 03rd 1969, less than two weeks before the launch of Apollo 11, when a loose bolt caused the largest explosion in the history of rocketry, destroying both the N1 rocket and the surrounding launch complex.

Within a month, the crew of Apollo 11 had successfully landed on the moon, and America had effectively won the Space race. The Soyuz program continued, but the Russian Space Program switched its focus to the development of the Salyut space stations, achieving a number of further milestones in space exploration. Although plans for a Russian moon landing continued into the 1970s, they were eventually cancelled altogether in 1974.