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Moon landings - Luna 9

Age 7-11 years

Credit-Pline

About

On the 3 February 1966, Luna 9 made history by being the first crewless space mission to make a soft landing on the surface of the Moon. It was the ninth mission in the Soviet Union's Luna programme (the previous five missions had all experienced spacecraft failure). The Soviet Union existed from 1922 to 1991 and was the largest country in the world; it was made up of 15 states, the largest of which was the Russian Republic, now called Russia. The Space Race is a term that is used to describe the competition between the United States of America and the Soviet Union which lasted from 1955 to 1969, as both countries aimed to be the first to get humans to the Moon.

Working scientifically

The Luna 9 spacecraft had a mass of 98kg (about the same as a baby elephant) and it carried communication equipment to send information back to Earth, a clock, a heating system, a power source and a television system. The spacecraft included scientific equipment for two enquiries: one to find out what the lunar surface was like; and another to find out how much dangerous radiation there was on the lunar surface.

The engineers planning the mission had to find ways to make sure that the spacecraft had a soft landing so that the equipment wouldn't be damaged. As the Luna 9 spacecraft was falling towards the Moon's surface, four jets of gas were fired downwards to push the spacecraft upwards and slow it down. Just before it reached the surface, a huge airbag was inflated to reduce the impact force. The spacecraft bounced several times before eventually coming to rest, but the equipment managed to withstand the impact. Shortly after landing, four petal shaped shields that covered the top half of the spacecraft opened outwards to make sure the spacecraft was stable before it began its scientific exploration.

The camera on board took many photographs of the lunar surface including some panoramic images. These images were transmitted back to Earth using radio waves. Although the Soviet Union didn't release these photographs to the rest of the world, astronomers working at the Jodrell Bank Observatory near Manchester noticed that the signal was similar to the one used at the time by newspapers for transmitting pictures. The Daily Express brought their equipment up to the Jodrell Bank telescope and managed to decode the images from Luna 9 and published the photographs worldwide.

Scientists were able to use the images collected to find out many things about the lunar surface, including the size and number of craters as well as whether the ground would support a spacecraft landing without it sinking into the dust.

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Moon landings - Apollo 11

Age 7-11 years

About

On 20 July 1969, Apollo 11 became the first crewed spacecraft to land on the surface of the Moon. The Apollo 11 mission was part of the United States of America's National Aeronautics and Space Administration (NASA) Project Apollo. Commander Neil Armstrong and pilot Buzz Aldrin landed the Apollo lunar lander known as Eagle on the lunar surface while Michael Collins flew the command module known as Columbia in orbit around the Moon. Armstrong was the first human to step on the surface of the Moon; as he made that historical step, he said the famous phrase: "That's one small step for [a] man, one giant leap for mankind".

Credit-NASA

Working scientifically

Eagle, the Apollo lunar lander, had a number of different pieces of equipment onboard so that Armstrong and Aldrin could collect data and make observations for a number of different enquires. This included a television camera that collected footage of the lunar surface and recorded the astronauts carrying out tasks and working scientifically. The black and white footage of the first lunar extravehicular activity (EVA) was broadcast to over 600 million people on Earth.

Armstrong and Aldrin explored the lunar surface in an area up to 90 metres from the Eagle lander, collecting soil and rock samples to take back to Earth for closer observations and testing. Armstrong collected two core samples from the edge of a crater; he used a geologist's hammer to strike tubes 15cm into the ground and collect a sample in the shape of a cylinder so that layers in the rock and soil could be observed. The mission brought back over 20kg of lunar rock and soil. Geologist's back on Earth identified familiar rocks in the sample – basalt and breccia – but they also discovered three new minerals.

One of these minerals was named armalcolite after the three astronauts; all three of these minerals have since be discovered on Earth.

Buzz Aldrin set up the Early Apollo Surface Experiments Package (EASEP) which included equipment for two more enquiries. One of the pieces of equipment was called a seismometer and was used to observe and measure moonquakes (vibrations in the ground) over time.

Armstrong and Aldrin also had great fun investigating what was the best way to move in lunar gravity. The astronauts would have only felt a sixth of the weight that they felt on Earth which made moving very different. They carried out comparative tests to find out which was the best way to move around quickly without falling over. They tried different ways of walking, skipping and even two footed kangaroo hops. I the end, they concluded that loping was the best way to move around and keep their balance, this involved taking long, bounding strides.

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Moon landings - Apollo 15

Age 7-11 years

About

On 30 July 1971, Apollo 15 became the fourth crewed spacecraft to land on the surface of the Moon. The Apollo 15 mission was part of the United States of America's National Aeronautics and Space Administration (NASA) Project Apollo. It was the first extended mission and astronauts David Scott, Alfred Worden and James Irwin spent three days exploring the Moon. Scott and Irwin explored the surface of the Moon using the first lunar rover while Worden orbited the Moon in the command module, Endeavor. On the way home, Worden was the first astronaut to perform a spacewalk in deep space.

Credit-NASA

Working scientifically

Having a lunar rover enabled the astronauts to explore a much larger area than on previous missions. The rover carried television cameras so that geologists on Earth could follow Scott and Irwin's exploration. On their first extravehicular activity (EVA) they drove to two different craters to collect rock and soil samples to bring back to Earth.

After they returned to the spacecraft to drop off the samples, they set up the Apollo Lunar Surface Experiments Package (ALSEP) which was a collection of experiments that would stay on the Moon after the astronauts returned to Earth. One of the experiments was to find out how quickly the centre of the Moon was cooling down. It involved the astronauts drilling two holes 2.5m deep and inserting two temperature probes to measure changes in temperature over time.

Another experiment in the ALSEP was a laser retroreflector which was used to reflect a laser beam from Earth. These reflectors were left behind at all of the Apollo landing sites and are the only Apollo experiments still being used today. They are used to make measurements that allow astronomers to carefully track the Moon's movement and its distance from Earth.

The ALSEP also included at magnetometer which measured the lunar magnetic field. The mission discovered that the Moon's magnetic field is much weaker than the Earth's magnetic field. Scientists believed that the magnetic field detected by the magnetometer was due to magnetic rocks on the Moon's surface.

While on the Moon, Scott also performed the famous gravity experiment discussed by Galileo 400 years ago. He dropped a feather and a hammer to prove that all objects in the same gravity field fall at the same rate, no matter what mass they have. The Moon was a good place to carry out this experiment because there was no atmosphere to create air resistance forces to slow the objects down. The hammer and feather hit the ground at the same time.

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Moon landings - SELENE (Kaguya)

Age 7-11 years

About

SELENE was a crewless, lunar orbiter that was developed by the Japanese Aerospace Exploration Agency (JAXA). The spacecraft was launched on 14 September 2007 and after successfully orbiting the Moon for a year and eight months, it impacted into the lunar surface on the 10 June 2009. In Japan, the spacecraft is better known by its nickname Kaguya which is also the name of the lunar princess in the ancient Japanese folktale 'The tale of the Bamboo cutter'.

Credit-JAXA

Working scientifically

The Kaguya spacecraft carried many different pieces of equipment for making measurements.

By analysing the light that was reflected from the Moon's surface, Kaguya was able to collect data so that the rocks that cover the entire lunar surface could be identified. This equipment was able to accurately identify the different chemicals that can be found on the lunar surface.

A piece of measuring equipment called an altimeter used lasers to make accurate measurements between the orbiter and the lunar surface. The huge amounts of data from this piece of equipment from across the entire Moon enabled a very accurate and precise 3D map to be made of the lunar surface. This data was shared with Google so that they could create Google Moon 3D.

The spacecraft also carried radar equipment that could use radio waves to find out the sizes and angles of objects on the Moon's surface. It was this equipment that help the mission discover an enormous cave, 50km long and 100m wide. JAXA said that they thought the cave could be turned into an exploration base for astronauts. Kaguya collected lots of data from the cave and scientists are quite sure that the structure is solid and safe. The cave would protect astronauts from extreme temperatures and dangerous UV radiation as well as shielding them from meteorites.

Kaguya also accurately measured the strength of the Moon's gravity across the entire surface of the far side of the Moon. The area is very different to the near side and scientists think the reasons for these differences will help them understand how the Moon formed 4.5 billion years ago. The Kaguaya spacecraft identified a number of regions on the far side of the Moon where the gravity is stronger than in other places which they are trying to explain.

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Moon landings - Chandrayaan-1

Age 7-11 years

About

Chandrayaan-1 was the first spacecraft that India sent to the Moon. The spacecraft was crewless and included a part that would stay in orbit around the Moon and a part that would impact with the lunar surface. Chandrayaan-1 was launched on 22 October 2008 and was in lunar orbit by 8 November 2008. One of the main reasons for the mission was to hunt for lunar water-ice that will be essential for the development of future human settlements on the Moon.

Credit-ESA

Working scientifically

Both parts of the Chandrayaan-1 spacecraft carried eleven different measuring instruments to collect data to learn more about the Moon. One of these instruments was the Terrain Mapping Camera which was the most advanced camera to completely map the surface of the Moon and produced a high-resolution map.

Like previous missions to the Moon, there were also instruments called spectrometers that are able to analyse reflected light from the lunar surface to identify exactly what chemicals it is made from. Data collected from the mission showed large quantities of rocks that had iron in them. The data collected about the minerals spread across different areas of the lunar surface helped to confirm the idea that at one time the Moon was completely molten.

The Moon Impact Probe (MIP) crashed into the lunar surface on 14 November 2008, very close to the south pole of the Moon. As the probe fell to Earth it also used a spectrometer to analyse light reflected from the Moon's thin atmosphere and discovered evidence of water. The probe also analysed the plume of material thrown up from beneath the Moon's surface during the impact and found even more evidence of water. This was the first proof that there is water on the Moon, a discovery that has since been confirmed by NASA. Most of the newly discovered water lies in the shadows of craters near the poles in areas where sunlight never reaches so it is frozen.

The Chandrayaan-1 mission collected huge amounts of data from the instruments onboard. This data has been shared with teams of scientists and engineers around the world who are still analysing it, looking for patterns and making predictions about what it means. The analysis of the data has helped to answer some of scientists' biggest questions about the Moon, but it has also led to many more questions, that can only be answered by returning.

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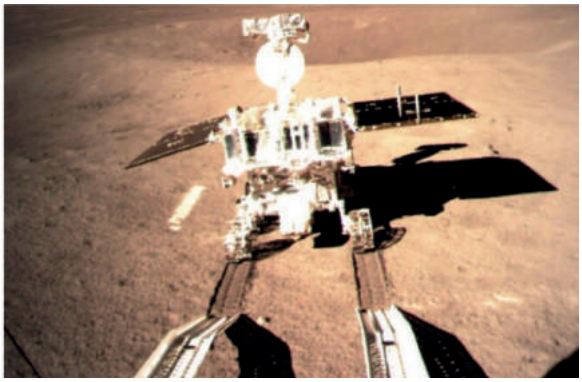
Age 7-11 years

Research cards

Moon landings - Chang'e 4

About

On 3 January 2019, China's crewless Chang'e 4 spacecraft was the first to make a soft landing on the far side of the Moon. The spacecraft included a robotic lander and a remotely controlled rover called the Jade Rabbit. The Chinese Luna Exploration programme has named many of their missions after Chang'e, the Chinese goddess of the Moon.



Credit-CNSA

Working scientifically

The Chang'e 4 spacecraft carried many experiments. The Jade Rabbit rover was designed to explore the area around a very large crater called the Aitken Basin which is 13km deep. Scientists think that when this crater was formed it may have thrown up material from deep within the crust and probably the mantle below. The Jade Rabbit will collect samples of rocks and soils surrounding the crater and analyse them to find out about the chemicals that they are made from. Scientists think that data from this enquiry will help them learn more about the layers inside the Moon and how the Moon formed 4.5 billion years ago.

The Chang'e 4 mission was also designed to observe how the temperature of the Moon changes over time using electronic temperature sensors. This experiment was designed to last the entire length of the mission and will provide large quantities of temperature data for scientists on Earth to analyse, exploring patterns and trends.

The lander also includes a special piece of equipment called a neutron dosimeter which will be carefully measuring the levels of dangerous radiation to help plan for keeping astronauts safe during future human exploration of the Moon. This equipment will also be able to collect data to investigate the solar wind, a stream of radiation coming from the upper atmosphere of the Sun.

The Chinese Space Agency asked students around the country to share their ideas for experiments to be included in the Chang'e 4 mission. The winning entry was a mini- biosphere which contained seeds of potato, rapeseed and cress as well as fruit flies and some yeast. The idea was that the six organisms could make up a micro-ecosystem; the plants could produce oxygen and food for the fruit flies and the yeast could process the dead plants and the waste from the flies. The seeds germinated and began to sprout but unfortunately the biosphere didn't have a built-in heater and they all died from the cold temperatures of the lunar night. Learning about how to best grow plants on the lunar surface is important for the development of future human settlements; potatoes and cress could provide food, rapeseed could provide oil and cotton could be used to make clothes.

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Age 7-11 years

Writing framework

Name ..... Research team .....

Which moon landing are you researching?	
Which country developed and launched this mission?	
When did this mission take place?	
What was most significant about this mission?	
What working scientifically skills were shown on this mission?	
Why was this mission important?	
What other interesting facts did you discover about this mission?	
What else would you like to know about this mission?	