



Water Rokit

NASA ARTEMIS LESSONS

A NIGHT TO REMEMBER

On **16th November 2022 in Florida, USA**, a colossus sat in the pitch-black night.

The beast was bigger than Big Ben and the Statue of Liberty.

After years of research and development, this colossus was designed to **fly to the Moon and back!**

What do you think we're talking about?

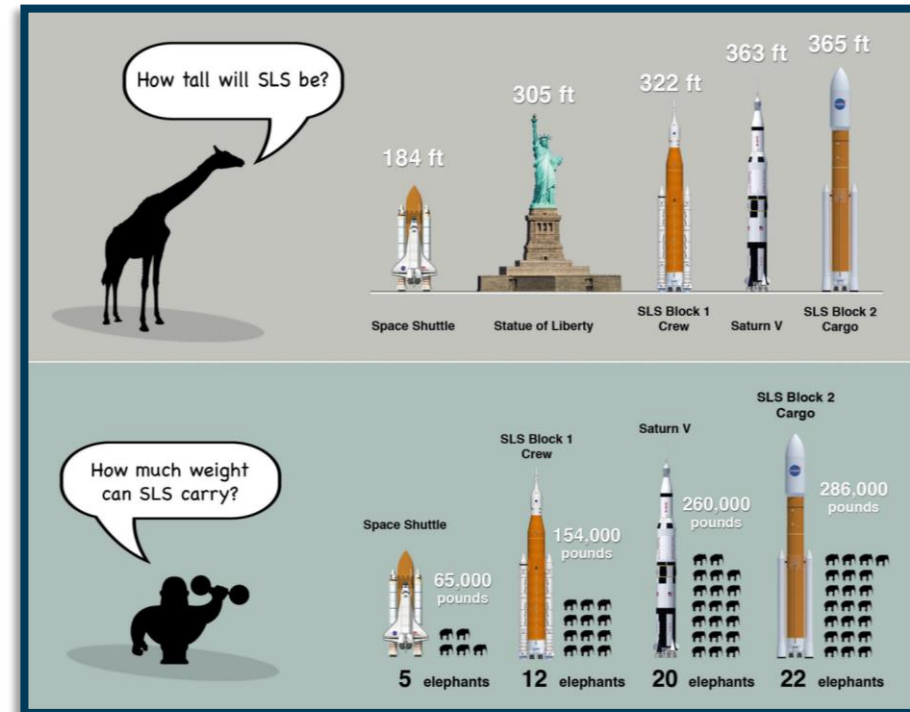
MEET NASA'S MEGA ROCKET...

...the Space Launch System (SLS) - the most powerful rocket ever!



HOW MANY ELEPHANTS CAN THE SLS CARRY?

- When carrying **crew**, the SLS can carry **154,000 pounds (or 69,853kg)**
– **that's 12 elephants!**
- When carrying **cargo**, the SLS can carry **286,000 pounds (or 129,727kg)**
– **that's 22 elephants!**



NASA'S SPACE LAUNCH SYSTEM (SLS)

On top of the SLS rocket sits a large, heavy capsule named **Orion**.

Orion can carry **4 astronauts** and contains everything needed for travelling into deep Space – it's where the crew eats, sleeps, works, etc.



AN OVERVIEW OF ARTEMIS 1

Who can tell me what the Artemis Programme is?



WHAT IS THE ARTEMIS PROGRAMME?

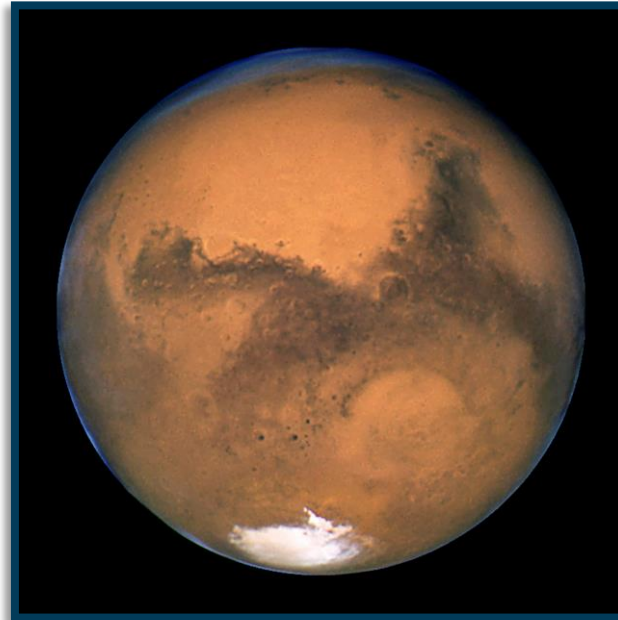
The goal of NASA's Artemis programme is to **put astronauts on the lunar surface** (the Moon), and to **develop an ongoing presence there.**

The Artemis mission's objectives involve them making use of the Moon as a **stepping stone for a mission onwards to Mars.**



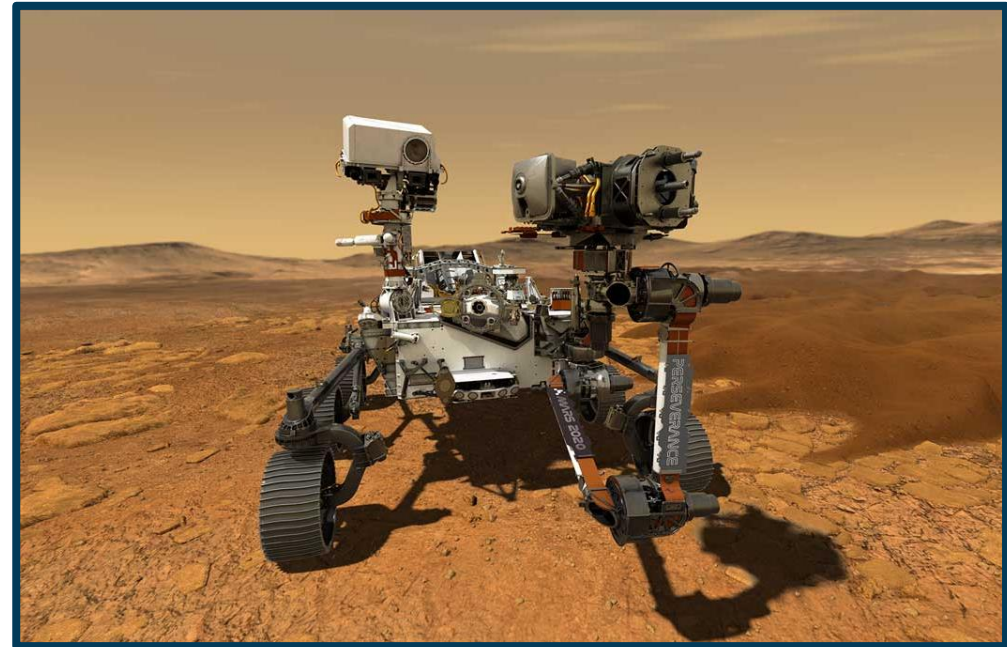
A TRIP TO MARS

Do you think you would like to go to Mars? What do you think it would be like?



NASA'S PREPARATION FOR VISITING MARS

Robots have done all the detective work on Mars so far, but NASA now aims to send astronauts there. **The return to the Moon will provide us with valuable data, knowledge, and tools to prepare us for visiting Mars.**



HOW FAR AWAY IS THE MOON FROM EARTH?

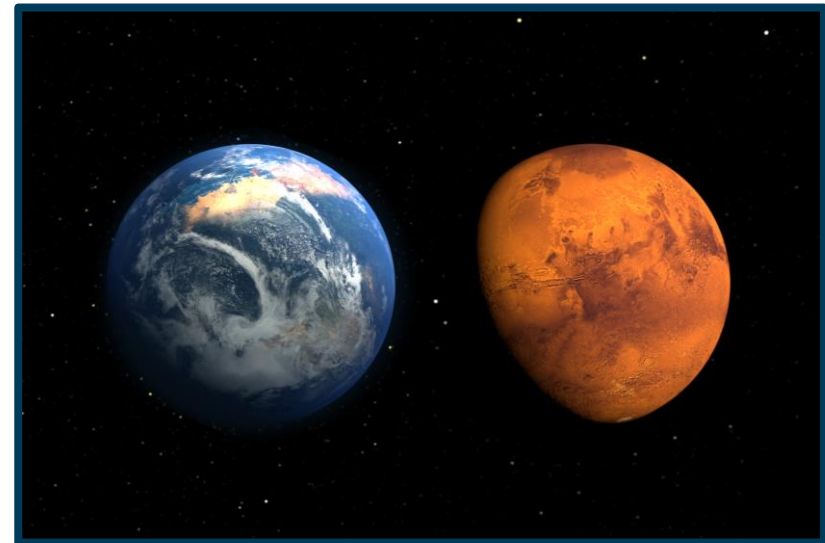
Approximately **250,000 miles** – so a round trip from Earth and back is 500,000 miles. A bit too far away for a weekend break.



HOW FAR AWAY IS MARS FROM EARTH?

On average, Mars is about **140 million miles** from Earth.

Getting to Mars is a **7 or 8-month journey**, and when you get there, you would have to **wait 15 months** for the planets to align correctly again **before you were able to return to Earth.**



QUIZ — AN OVERVIEW OF ARTEMIS 1

1. What is the goal of the Artemis programme?
2. Who is Artemis in Greek Mythology?
3. What was the name of the Space programme that first brought astronauts to Earth's natural satellite, the Moon, on 20th July 1969?



QUIZ ANSWERS — AN OVERVIEW OF ARTEMIS 1

1. The goal of NASA's Artemis programme is to put astronauts on the lunar surface (the Moon), and to develop an ongoing presence there.
2. Artemis is the Greek goddess of the Moon.
3. The Apollo Programme.



THE ARTEMIS MISSION 1, 2 & 3

Artemis 1

On **16th November 2022** at **01:47am ET**, NASA successfully launched Artemis 1 at NASA's **Kennedy Space Centre in Florida**.

The first mission was to send the Orion Spacecraft 'uncrewed'.

This was to **test the safety of the SLS rocket**, and the **capsule's ability to reach the Moon, perform a lunar orbit, and return to Earth for an ocean splashdown**.



THE ARTEMIS MISSION 1, 2 & 3

Artemis 2

Planned for **2024**, carrying the **first four Artemis astronauts**, the Orion will transport the crew **farther from Earth than humans have ever travelled before.**

Over the 10-day mission, the crew will complete a lunar flyby and return to Earth, evaluating the spacecraft's systems, while carrying humans.



THE ARTEMIS MISSION 1, 2 & 3

Artemis 3

Planned for **2025**, we will see **the next man and first woman step onto the Moon.**

Providing the previous missions have been successful, the astronauts will fly to the Moon and **remain there for approximately one week**, conducting experiments.



THE GATEWAY SPACE STATION

The Gateway is a vital component of NASA's Artemis programme. It will serve as a multi-purpose outpost, orbiting the Moon, that provides a platform for scientific experiments.



QUIZ — THE ARTEMIS MISSION 1, 2 & 3

1. What's the purpose of the mission for...

- a) The Artemis 1 mission?
- b) The Artemis 2 mission?
- c) The Artemis 3 mission?

2. What's the purpose of the Gateway Space Station?



QUIZ ANSWERS — THE ARTEMIS MISSION 1, 2 & 3

1. What's the purpose of the mission for...
 - a) To send the Orion spacecraft 'uncrewed' (that is with no astronauts aboard) to test the safety of the SLS rocket and the capsule's ability to reach the Moon, perform a lunar orbit and return to Earth for an ocean splashdown.
 - b) To carry the first four Artemis astronauts, the Orion will transport the crew farther from Earth than humans have ever travelled before.

QUIZ ANSWERS — THE ARTEMIS MISSION 1, 2 & 3

- c) To see the next man and first woman step onto the Moon.
- 2. The Gateway will serve a similar function to the ISS. Just like the International Space Station that orbits Earth, it will house its astronauts whilst they work in Space.

THE ARTEMIS MISSION 1, 2 & 3

The mission was to **fly an empty capsule** in automatic mode, without a crew, **past the Moon, orbit around it, and return it to Earth.**

Three weeks after the launch, the capsule **lands in the Pacific Ocean.** One of the main goals of the first Artemis mission was to **test its ability to safely re-enter the atmosphere and land in the right place back on Earth.**



WHAT MAKES UP THE SLS & ORION CAPSULE?



Orion spacecraft: An uncrewed Orion spacecraft will venture thousands of miles beyond the Moon, paving the way for future flights with astronauts.

Orion stage adapter: The adapter carries small satellites to deep space where they conduct world-class science for pennies on the dollar.

Interim Cryogenic Propulsion Stage (ICPS): One RL10 engine provides 24,750 pounds of thrust to send Orion to the Moon.

WHAT MAKES UP THE SLS & ORION CAPSULE?



Launch vehicle stage adapter: The adapter connects the 27.5-foot diameter core stage to the 16.5-foot diameter ICPS and partially encloses the ICPS in-space stage.

Core stage: The 212-foot tall core stage holds 733,000 gallons of propellant to power four RS-25 engines for eight minutes, sending the rocket soaring to Space at 17,000 miles per hour.

WHAT MAKES UP THE SLS & ORION CAPSULE?



Solid rocket boosters: Each 17-story-tall booster generates 3.6 million pounds of thrust, providing 75% of total thrust during the SLS rocket's first two minutes of flight.

Four RS-25 engines: As the most efficient engines ever built, the engines provide a total of two million pounds of thrust for launch and ascent to space.

Want to learn how to draw the SLS?
Check out [this guide!](#)

QUIZ — WHAT MAKES UP THE SLS & ORION CAPSULE?

1. What does the Orion's stage adapter carry and release into Space?
2. What percentage of power do the two solid rocket boosters provide to the rocket during launch?
3. How many engines power the core stage of the rocket?



QUIZ ANSWERS — WHAT MAKES UP THE SLS & ORION CAPSULE?

1. The adapter carries small satellites to deep Space where they conduct world-class science for pennies on the dollar.
2. The boosters provide 75% of the rocket's thrust during launch for its first two minutes of flight.
3. 4 engines.

BUILDING THE BIGGEST ROCKET IN THE WORLD

The SLS project began in **2011** – involving a team of people that stretched across **fifty states of America** and **70,000 jobs and businesses**, with further input and development from European countries.



WELCOME TO THE VEHICLE ASSEMBLY UNIT (VAB)

- The VAB is based at the **Kennedy Space Centre** in Florida.
- The VAB is **one of the largest buildings in the world**.
- Its **high bay doors are the largest in the world** and take about **45 minutes** to completely open or close them.
- The building is 3-4 miles away from the launch pads, so a **'crawler'** carefully transports the rocket on a mobile launcher to the launch pad.



ORION AND THE EUROPEAN SERVICE MODULE — A QUICK SHOUT OUT

The Artemis programme really is a team effort. The European Space Agency (ESA) designed and developed Orion's service module, the part of the spacecraft that supplies air, electricity, and propulsion.

Mankind on the way to Mars and beyond

Orion European Service Module

For the first time, NASA will use a European built system as a critical element to power an American spacecraft.

The Orion programme
NASA is developing the capabilities needed to send humans to an asteroid and Mars.

1st European supply of critical functions for an American space mission:

- Spacecraft propulsion
- Electrical power supply
- Consumable storage (water and air)
- Thermal control

Main dimensions:
4.1 m diameter
9 m length

As prime contractor to ESA Airbus Defence and Space provides the following:

- Programme management
- The propulsion subsystem
- Systems engineering
- Solar arrays
- Integration and test of the ESM
- Operations support

The Airbus Defence and Space experience
The Orion European Service Module is testimony to the excellent technologies and expertise of the Airbus Defence and Space team demonstrated by designing and building the highly successful Automated Transfer Vehicle, the largest supplies carrier to the International Space Station, that will serve as the design base.

Orion European Service Module

Crew Module

Crew Module Adapter

European Service Module

NASA Orion launch system

Airbus Defence and Space (AAS) © 2019

QUIZ — WELCOME TO THE VEHICLE ASSEMBLY UNIT (VAB)

1. What is the VAB's purpose? Why was it constructed?
2. How long does it take to close and open the VAB's doors?
3. What is the name of the vehicle that is used to transport the rocket to the launch pad?



QUIZ ANSWERS — WELCOME TO THE VEHICLE ASSEMBLY UNIT (VAB)

1. The VAB is where you can assemble, stack, and work on different levels of the rocket at the same time.
2. 45 minutes.
3. The crawler.



WHO HAS HITCHED A RIDE INSIDE THE ORION SPACE CAPSULE?

The first important crew member to mention is **SNOOPY** – the famous beagle – who has previous history flying in rockets with NASA, and **Shaun the Sheep**, who is representing the European Space Agency, is on board too, both sporting their replica Space outfits.

Snoopy and Shaun are **zero gravity indicators**, or zero 'g' indicators for short.



WHO HAS HITCHED A RIDE INSIDE THE ORION SPACE CAPSULE?

The Orion Space Capsule also carried some unconventional crew members on its journey around the Moon.

Rather than astronauts, a mannequin named **Commander Moonikin Campos** helmed the spacecraft, with two mannequin torsos called **Helga** and **Zohar** along for the ride.



WHO IS MOONIKIN CAMPOS?

Commander Moonikin Campos is named after a NASA electrical power subsystem manager who helped the troubled Apollo 13's safe return to Earth.

Moonikin Campos wore the 'Orion Crew Survival System Flight Suit' and **collected crucial data on what future human crews may experience.**

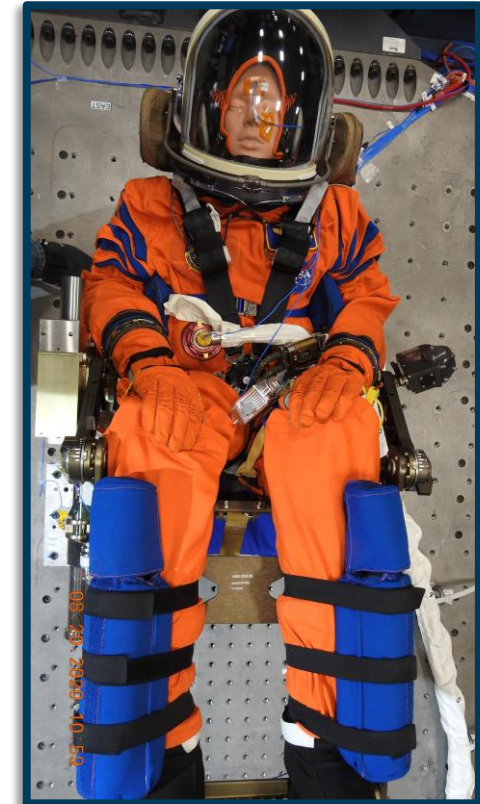
This suit can sustain a crew member for up to six days in the event of an in-Space emergency.



ORION CREW SURVIVAL SYSTEM FLIGHT SUIT

The Orion Crew Survival System Flight Suit is like a personalised, mini spacecraft that protects the crew member.

Commander Moonikin Campos' seat has **shock absorbers** in case of landing in rough seas or other scenarios. **The suit is weighted to resemble a real astronaut** and it's designed to work together with the seat.



PHANTOM TWINS

Helga and Zohar will **experience deep Space radiation** inside Orion.

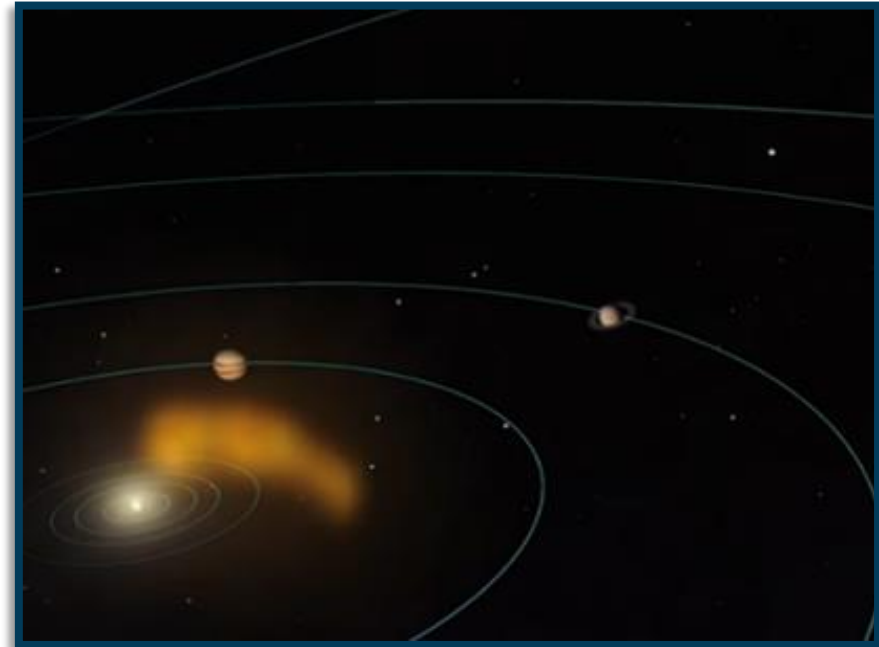
They are made of materials that mimic the soft tissue, organs, and bones of a woman to **test how radiation passes through the human body.**



WHAT ARE SPACE RADIATION & SOLAR STORMS?

Space radiation is a mixture of high energy, charged particles that originate from the Sun (and other solar systems), and is often dispersed in solar storms travelling nearly at the speed of light.

High levels of Space radiation can cause damage to the human body.



ASTRORAD

Zohar will wear AstroRad, a radiation protection vest, to test how effective it could be if future crews encounter a solar storm, while Helga will be unprotected.

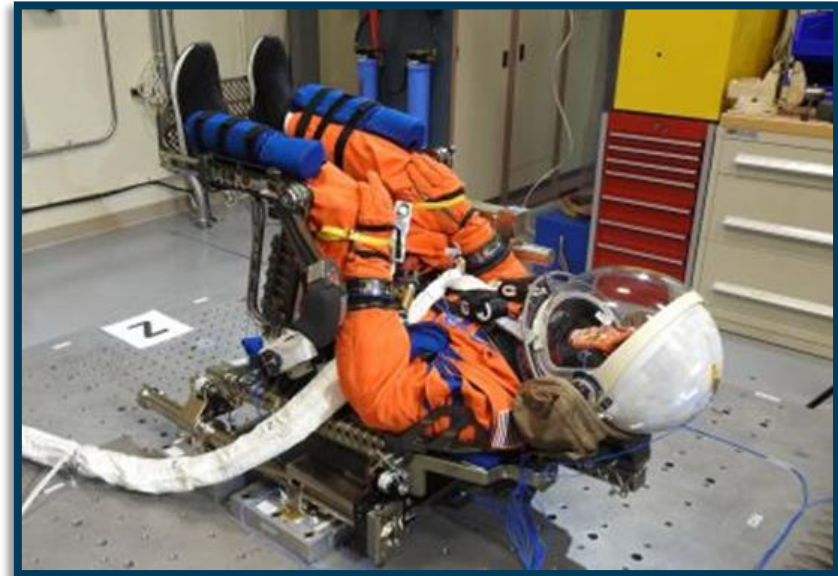
The AstroRad vest was recently tested on the International Space Station (see right).



SPACE RADIATION RESEARCH

The MARE project aims to measure the differences between **how specific organs**, such as the brain, **respond to radiation**.

Data returned by the Artemis 1 mission should have an impact on the standard limit of allowable radiation for both male and female astronauts.



QUIZ — WHO HAS HITCHED A RIDE INSIDE THE ORION SPACE CAPSULE?

1. What is a zero-gravity indicator, and how do you know it's working?
2. How far did the mannequins travel at their furthest point from our Moon?
3. What is Space radiation?

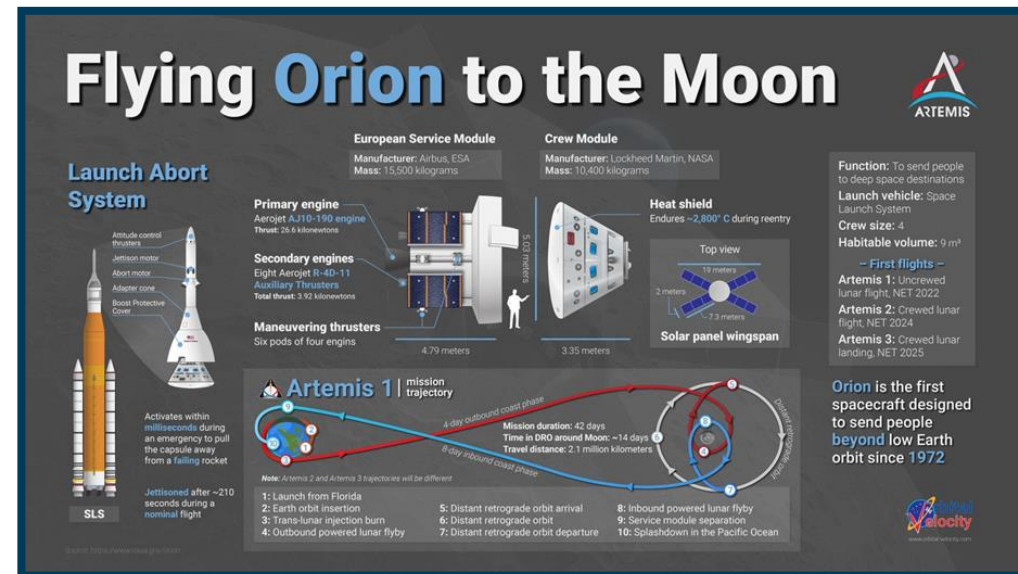


QUIZ ANSWERS — WHO HAS HITCHED A RIDE INSIDE THE ORION SPACE CAPSULE?

- 1. A zero 'g' indicator shows that you have broken free from the Earth's atmosphere, and the indicator will start to float in the capsule.**
- 2. A mannequin now holds the world record for going farther into Space than any human astronaut has gone before. (40,000 miles away at its furthest orbit from our Moon).**
- 3. Space radiation is a mixture of high energy, charged particles that originate from the Sun (and other solar systems), and is often dispersed in solar storms travelling nearly at the speed of light.**

STAGES OF THE ARTEMIS 1 MISSION

- **Flight day 1:** Launch
- **Flight day 2-5:** Outbound Transit
- **Flight day 6-9:** Transit to Lunar Orbit
- **Flight day 10-15:** Lunar Orbit
- **Flight day 16-19:** Exit Lunar Orbit
- **Flight day 20-26:** Return Transit
- **Flight day 26:** Splashdown (Dec 11)



LAUNCHING THE SLS

From Launch Complex 39B at NASA's Kennedy Space Centre in Florida:

Seconds after ignition, the SLS blasted off the pad and began its journey to the Moon. The ignition of the Space Launch System rocket was so powerful that it damaged its mobile launch platform.

During launch, the SLS produced up to **39 million newtons (8.8 million pounds)** of thrust. NASA calls SLS the most powerful rocket in the world.



LAUNCHING THE SLS

Climbing with immense acceleration, the twin SLS solid rocket boosters only burnt for **two minutes** and then their job was done. **They detached from the craft and fell into the ocean.**

Meanwhile, the core stage continued firing until about **eight and a half minutes after lift-off.** These also **detached from the spacecraft and tumbled into the sea.**

Once this happened, one more upper stage engine briefly ignited, **putting Orion into Earth's orbit.**

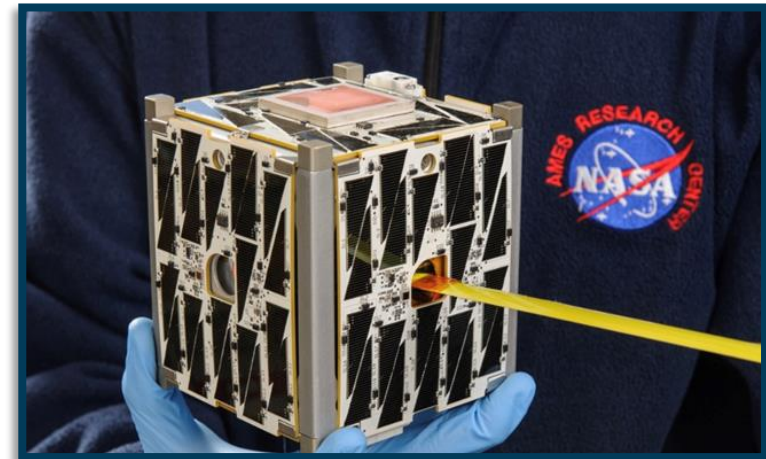


CUBESATS

Once Orion had drifted a safe distance away from the SLS upper stage, this stage was able to **deploy small satellites that were hiding inside, called CubeSats.**

One of the CubeSats made a slow flyby of an asteroid which measures just 18 metres across. The solar sail spacecraft captured **humanity's first up-close images of an asteroid this small.**

The other CubeSats had different jobs to do, including four aimed at **studying the Moon.**



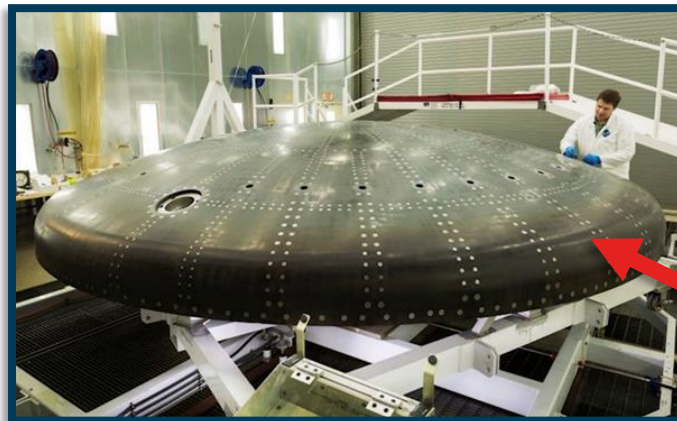
TERMS TO REMEMBER

Lunar Orbit

Distant Retrograde Orbit (DRO)

Splashdown

Orion's heat shield



Orion's heat shield

ORION'S HEAT SHIELD

At **4.7 miles** above the Pacific Ocean, Orion's drogue parachutes deployed to slow the spacecraft even further.

Next came the pilot chutes and the main parachutes, which slowed Orion to **less than 20 miles per hour**.

The capsule then gently fell into the Pacific Ocean off the coast of San Diego in the States.



QUIZ — STAGES OF THE ARTEMIS 1 MISSION

1. What is the name of the small satellites that were deployed on the mission?
2. What is a Distant Retrograde Orbit?
3. What speed does the Orion spacecraft travel on re-entry into Earth?
4. Why does the Orion capsule need a heat shield?

QUIZ ANSWERS — STAGES OF THE ARTEMIS 1 MISSION

1. **CubeSats.**
2. **Distant means the orbit travels far from the Moon, while Retrograde means the orbit is opposite the Moon's direction of rotation. A DRO allows a spacecraft to remain stable for long periods of time using very little fuel.**
3. **25,000 miles per hour.**
4. **During re-entry from Earth's orbit, the air molecules can't get out of the way of Orion fast enough, compressing and heating up to temperatures of 2,800 degrees Celsius, or 5,000 degrees Fahrenheit. The craft has a heat shield that is designed to protect the vehicle until it slows down to a more manageable velocity.**

SOME QUESTIONS WHILST FLYING THE WATER ROKIT

Today as part of your rocketeer training and whilst flying your rockets, I want you to think of three similarities between your Water Rokit and NASA's SLS Rocket.



QUIZ — ABOUT THE ARTEMIS PROGRAMME

1. What is the name of the capsule that will carry astronauts to the Moon?
2. How many miles away is the Moon from Earth?
3. What is the name of the planned Space Station that will orbit the Moon?
4. What is the building called at the Kennedy Space Centre where the SLS is built, and stays until it flies?
5. Who hitched a ride inside the spacecraft on the Artemis 1 mission acting as zero gravity indicators, and went to the Moon and back?

QUIZ ANSWERS — STAGES OF THE ARTEMIS 1 MISSION

1. Orion.
2. 250,000 miles.
3. The Gateway.
4. The VAB (Vehicle Assembly Building).
5. Snoopy and Shaun the Sheep.



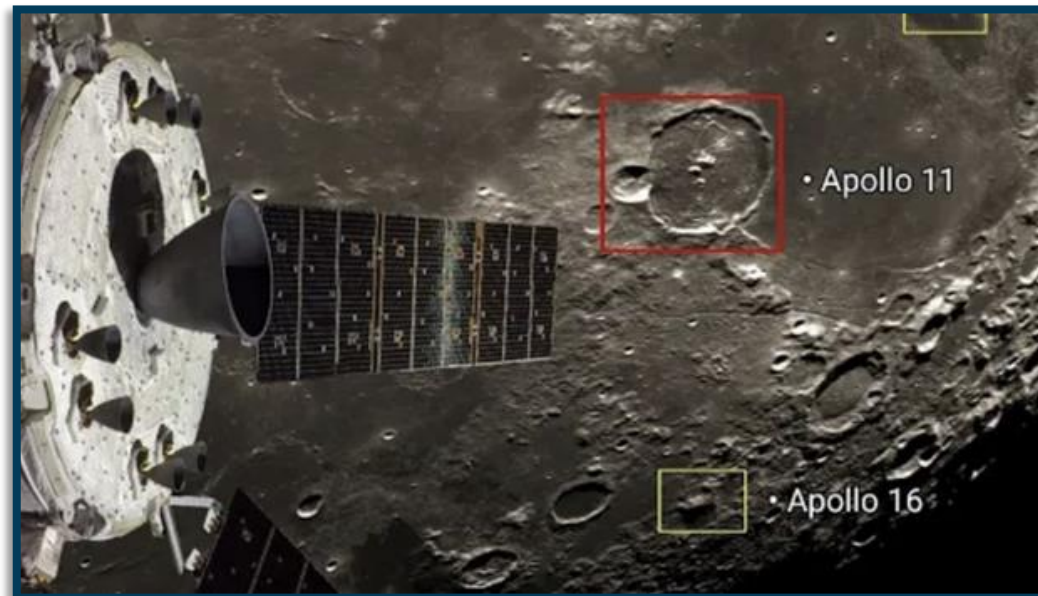
GALLERY

Our stunning planet Earth, from the Moon's perspective:



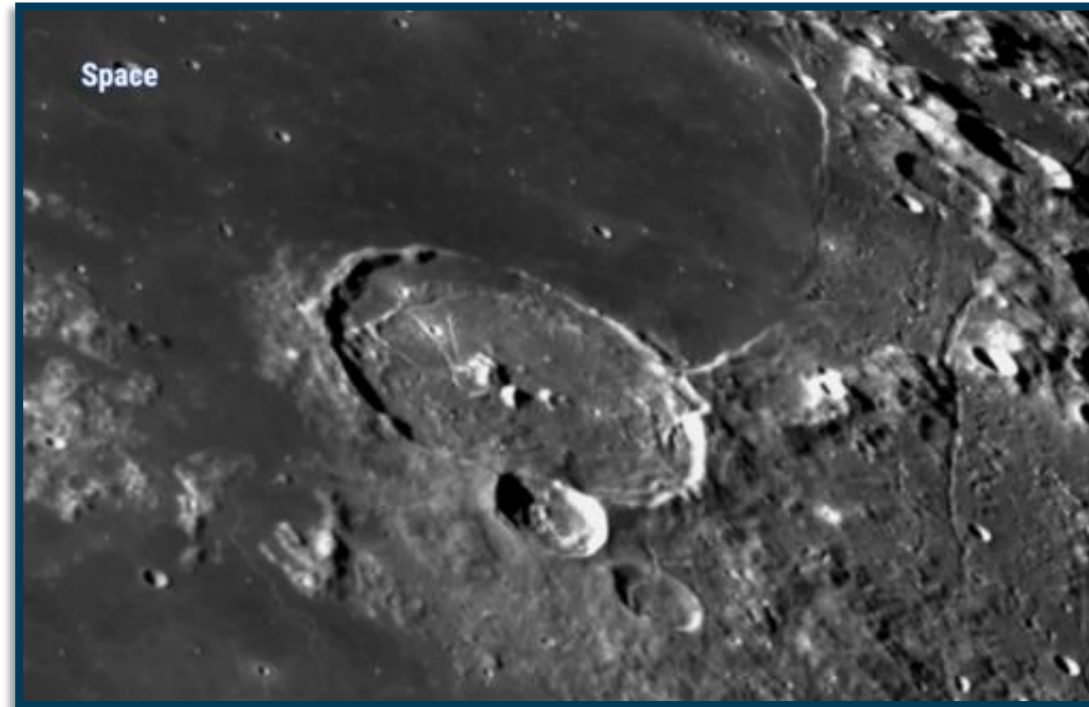
GALLERY

The spacecraft flying over the Apollo sites on the Moon where astronauts landed before:



GALLERY

Craters on the Moon:



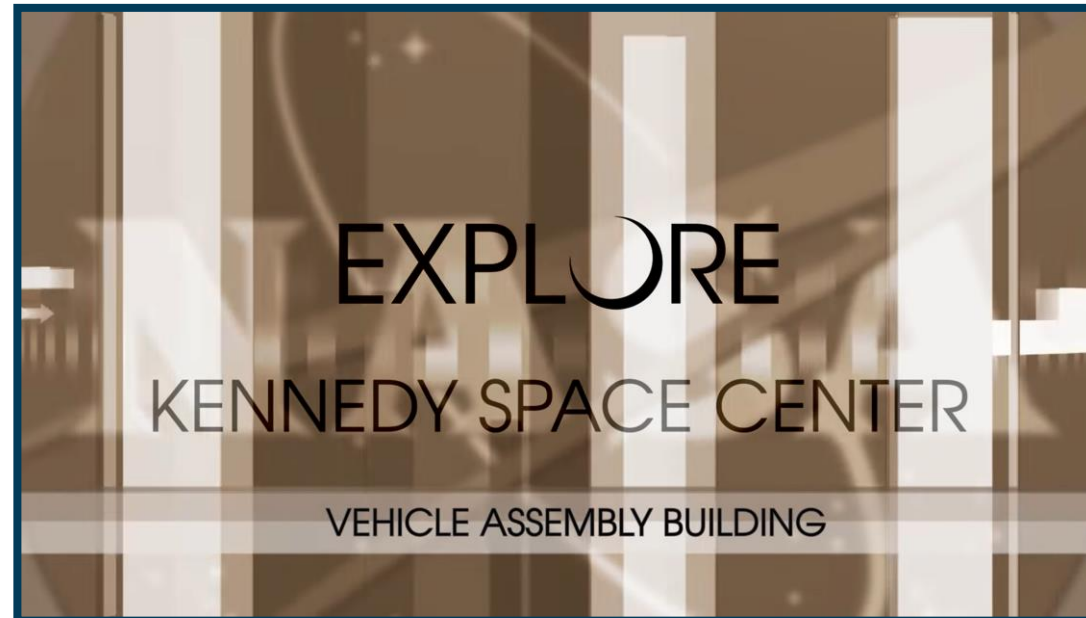
VIDEOS

Artemis I: We Are Ready



VIDEOS

Explore Kennedy Space Center: VAB



VIDEOS

NASA's Artemis I 'Passengers'



VIDEOS

Artemis I Mission Highlights

