Nasa Mars rover: Key questions about Perseverance

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Nasa Perseverance Mars rover

NASA / JPL-CALTECH

Nasa's Perseverance rover is sitting on the surface of Mars after a journey from Earth of almost seven months. Here, we answer some common questions about the mission.

What will the rover do?

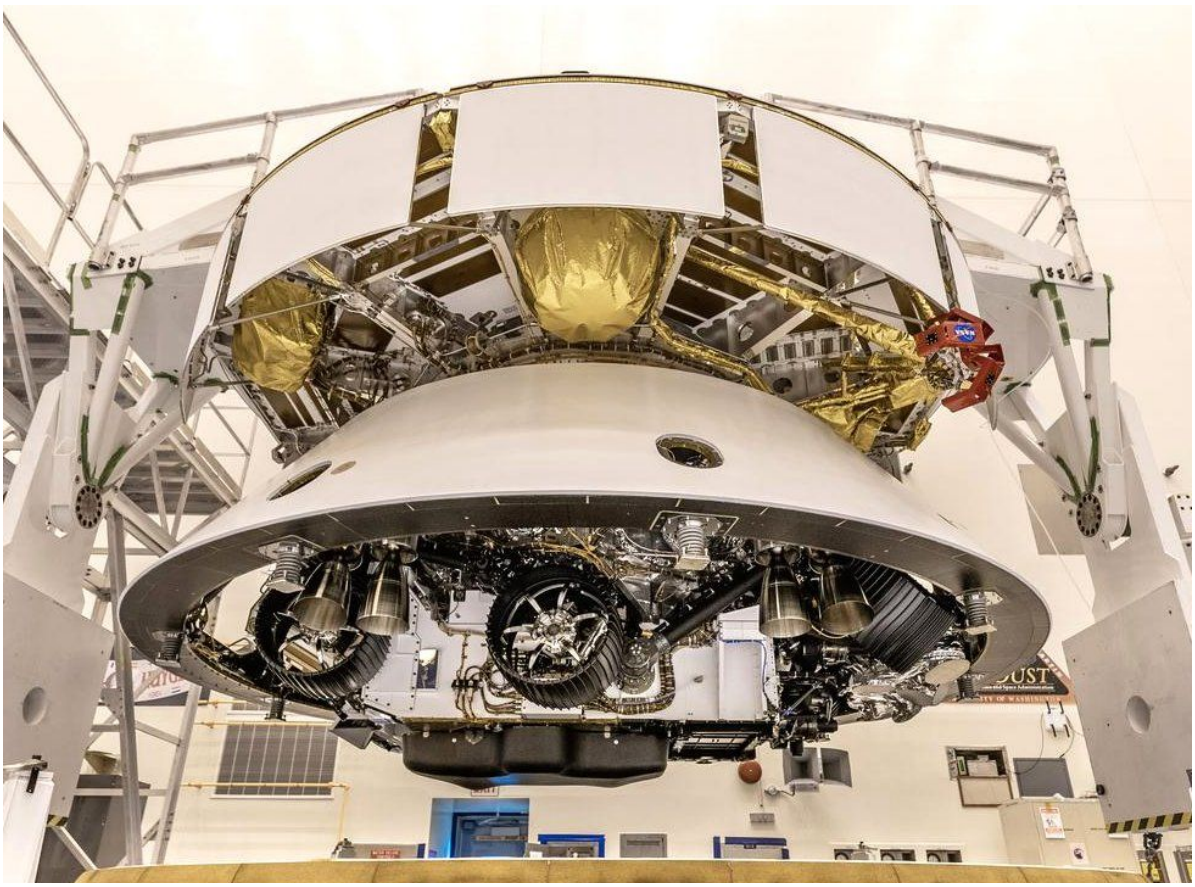
The Perseverance rover **touched down on the Martian surface** at 20:55 GMT (15:55 ET) on Thursday 18 February 2021.

The robot is designed to hunt for signs of past microbial life, if it ever existed. It is the first Nasa mission to hunt directly for these "biosignatures" since the Viking missions in the 1970s.

The rover will collect samples of rock and soil, encase them in tubes, and leave them on the planet's surface to be returned to Earth at a future date. Perseverance will also study the Red Planet's geology and test how astronauts on future Mars missions could produce oxygen from CO2 in the atmosphere. This oxygen could be used for breathing and rocket propellant.

In addition, a drone-like helicopter will be deployed to demonstrate the first powered flight on Mars. Perseverance will explore Jezero Crater, near the planet's equator, for at least one Martian year (about 687 Earth days).

How did it get to Mars?



The rover was encapsulated within an aeroshell, consisting of a backshell and heatshield

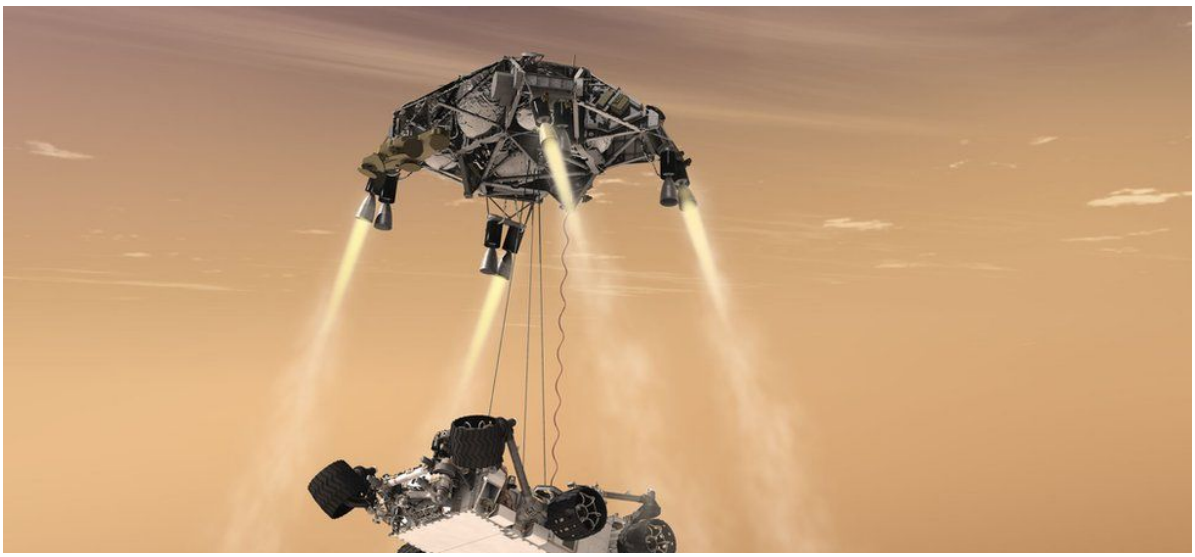
Perseverance was launched on 30 July 2020 from Cape Canaveral, Florida. The one-tonne, car-sized rover travelled through space enclosed in a protective aeroshell consisting of two parts: a conical backshell and a heat shield.

The aeroshell was connected to a cruise stage that fired thrusters to keep the spacecraft on course, ensuring it arrived at Mars in the right place for landing.

Technical specs: Perseverance rover

- **Length:** 3m (10ft)
- **Width:** 2.7m (9ft)
- **Height:** 2.2m (7ft)
- **Weight:** 1,025kg (2,260lbs)
- **Power source:** Multi-Mission Radioisotope Thermoelectric Generator (MMRTG). Converts heat from the radioactive decay of plutonium into electricity

How did Perseverance land?



Artwork: The rover was lowered to the ground on tethers

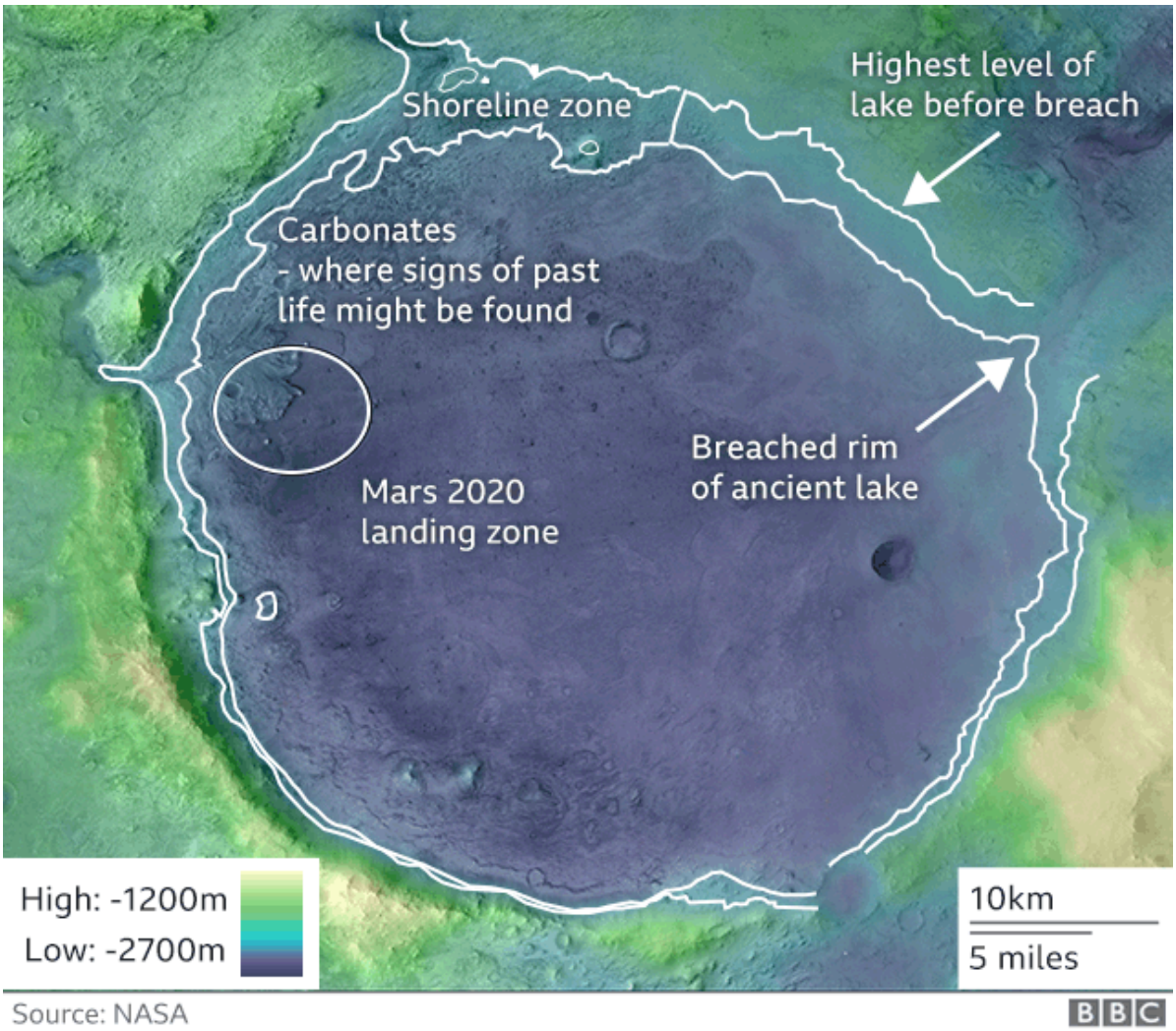
After a 470-million-km journey from Earth, the spacecraft ploughed through the Martian atmosphere. During this stage, its heat shield had to endure temperatures as high as 2,100C (3,800F).

When it was about 11km (7mi) above the ground, the spacecraft deployed a parachute, slowing the heaviest payload in the history of Mars exploration from a speed of Mach 1.7 (2,099 km/h; 1,304 mph) to about 320 km/h (200 mph).

The heat shield subsequently dropped away from the backshell and, for a short time, the rover - which was attached to a descent stage - fell freely towards the ground.

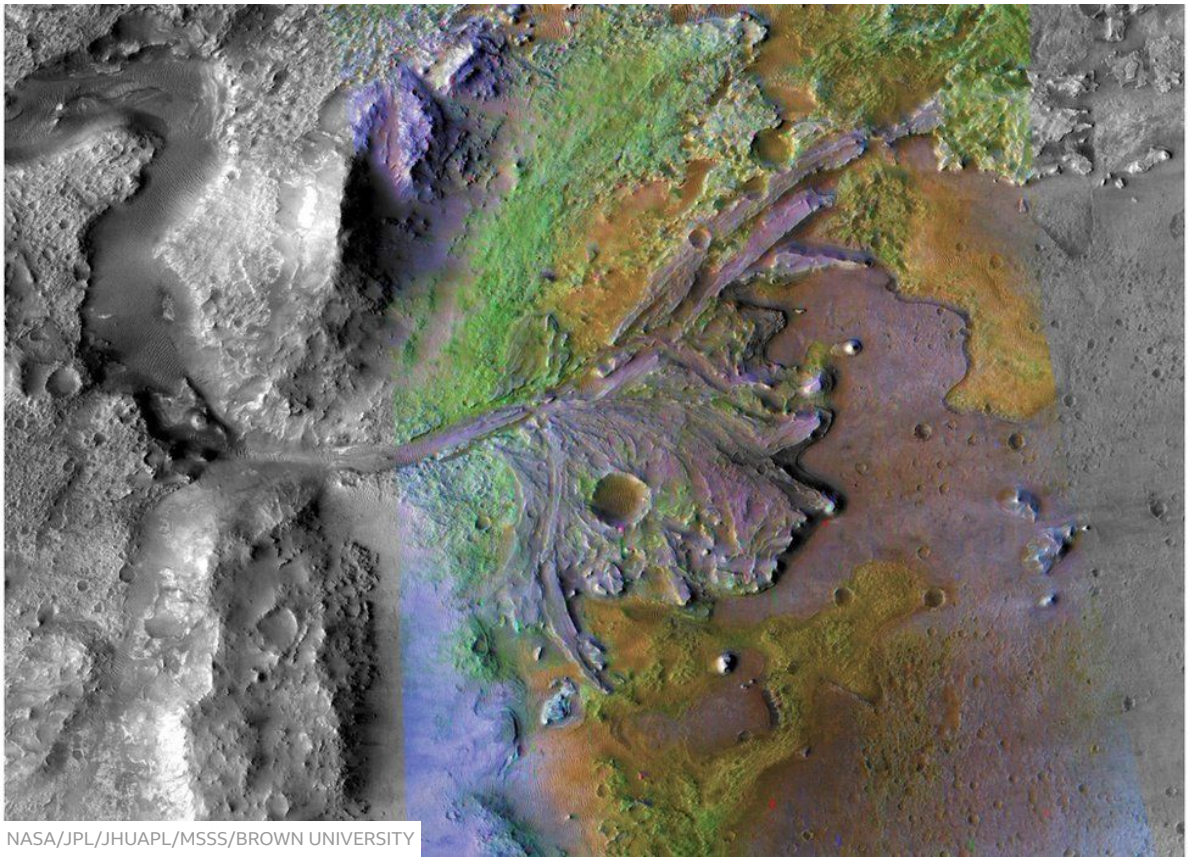
Eight retrorockets on the descent stage then fired, allowing the "sky crane" manoeuvre to be performed. Perseverance was lowered slowly on three nylon ropes and an "umbilical cord". When the rover's wheels touched the ground, the tethers were severed and the descent stage flew to a safe distance.

Where on Mars is it exploring?



The rover's landing site, Jezero Crater, is a 49km (30 mi) -wide impact depression just north of Mars' equator. More than 3.5 billion years ago, scientists think, river channels spilled over the wall of Jezero to form a lake.

The large bowl is also home to one of the best preserved Martian examples of a delta, a sedimentary structure that forms when rivers enter open bodies of water and deposit rocks, sand and - potentially - organic carbon in layers.



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Jezero's delta is one of the best preserved examples on Mars

Microbes could have lived in the crater when water was there. Jezero preserves a record of important geological processes such as impact cratering and volcanism, as well as the action of water. Studying its rocks will shed light on how the planet evolved over time.

How does the rover search for signs of past life?

Jezero's fan-shaped delta is one of the prime targets in the hunt for signs of past life. Scientists also see carbonate minerals deposited **around the crater's shoreline like the ring in a bathtub**. When carbonates precipitate out of water, **they can trap things that are in it, including evidence of life**.

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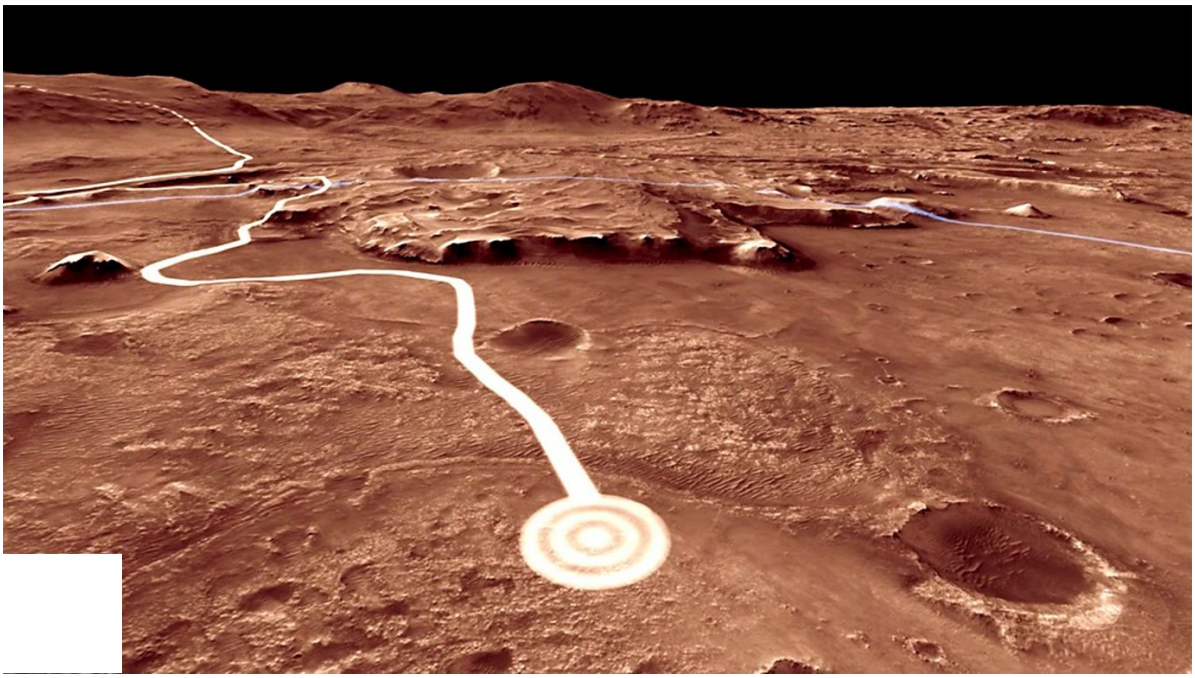
Stromatolites in Shark Bay, Australia

"We'll be searching for biosignatures - patterns, textures or substances that require the influence of life to form," says deputy project scientist Katie Stack Morgan.

We don't know what Martian biosignatures might look like, but the ancient Earth might provide clues. A record of our planet's early life can be found in stromatolites, rocks originally formed by the growth of layer after layer of bacteria. If similar structures exist on Mars, scientists could combine measurements from different instruments to assess the likelihood of a biological origin.

- **Will Nasa's next rover discover life on Mars?**



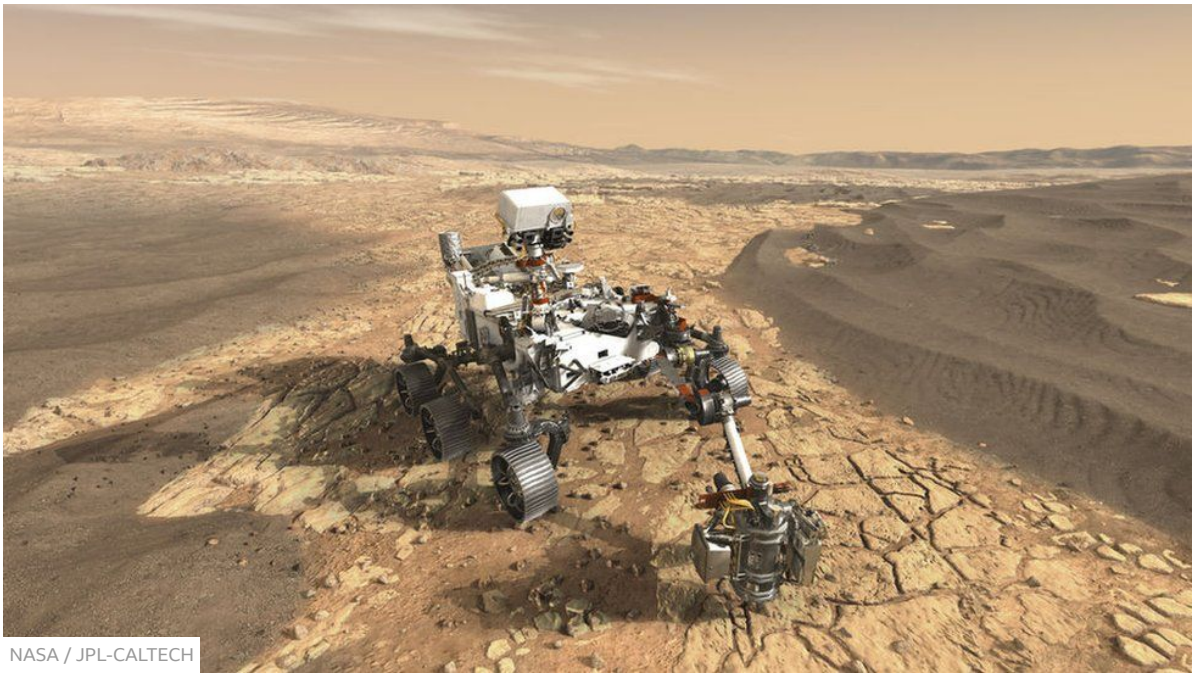
Drive with Nasa's next Mars rover through Jezero Crater

Why do scientists think there could have been life on Mars?

Today, Mars is cold and dry, with a thin atmosphere that exposes the surface to harmful levels of cosmic radiation. But billions of years ago, the planet appears to have been wetter, with a thicker atmosphere. Multiple lines of evidence, such as the presence of mudstones and sedimentary bands, show that there was once liquid water on the surface.

This is important because water is an essential ingredient for all life on Earth. Curiosity also found organic molecules preserved in sedimentary rocks three billion years old. While tantalising, it's not clear whether these organics preserve a record of ancient life, were their food, or have nothing to do with biological processes.

What instruments is the rover carrying?



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Perseverance is carrying an advanced payload of science instruments to gather information about Mars' geology, atmosphere, environmental conditions and potential biosignatures:

- **Mastcam-Z:** An advanced camera system to help study surface minerals
- **MEDA:** A Spanish-built sensor suite to measure temperature, wind speed and direction, pressure, humidity and dust
- **MOXIE:** Experiment to demonstrate how astronauts might produce oxygen from Martian CO2 for breathing and fuel
- **PIXL:** Has an X-ray spectrometer to identify chemical elements and a camera that takes close-up images of rock and soil textures
- **RIMFAX:** A Norwegian-built ground-penetrating radar that will map geology beneath the surface at centimetre scales
- **SHERLOC:** Will use spectrometers, a laser and camera to hunt for organics and minerals that were altered by water
- **SuperCam**: Will examine rock and soil with a camera, laser and spectrometers to look for organic compounds

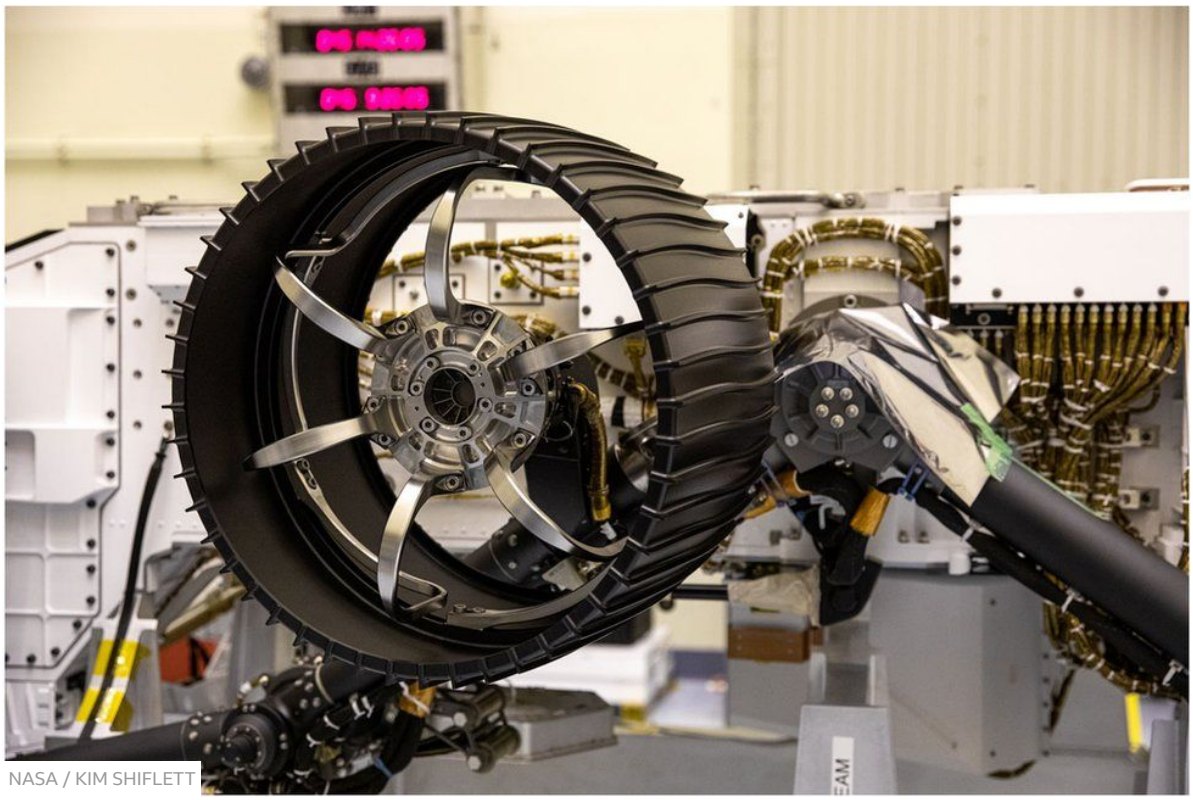
Why fly a helicopter on Mars?

A helicopter the size of a Chihuahua will explore Mars

Ingenuity is a 1.8kg (4lb) helicopter that will ride to Mars attached to the belly of Perseverance. Nasa wants to **demonstrate powered flight in Mars' thin atmosphere.** The Red Planet's gravity is lower (about one-third that of Earth's), but its atmosphere is just 1% the density of Earth's. This makes it harder to generate the lift required to get off the ground.

Equipped with two counter-rotating blades, the autonomous helicopter can take colour images with a 13-megapixel camera, the same type commonly found in smartphones. Rotorcraft could be a useful way to explore other worlds: flying vehicles travel faster than ground-based rovers, and can reach areas that are inaccessible to wheeled vehicles.

How does this rover differ from Curiosity?



NASA / KIM SHIFLETT

The wheels have been re-designed to make them more resistant to wear and tear

Perseverance is very similar to its predecessor Curiosity in terms of overall design, but there are key differences. As well as the new science payload, Perseverance has a larger "hand", or turret, on the end of its robotic arm to hold a heavier suite of tools, including a coring drill.

The system designed to cache samples is also a new feature. Engineers have re-designed the rover's wheels to make them more resistant to wear and tear. Curiosity's wheels sustained damage from driving over sharp, pointed rocks.

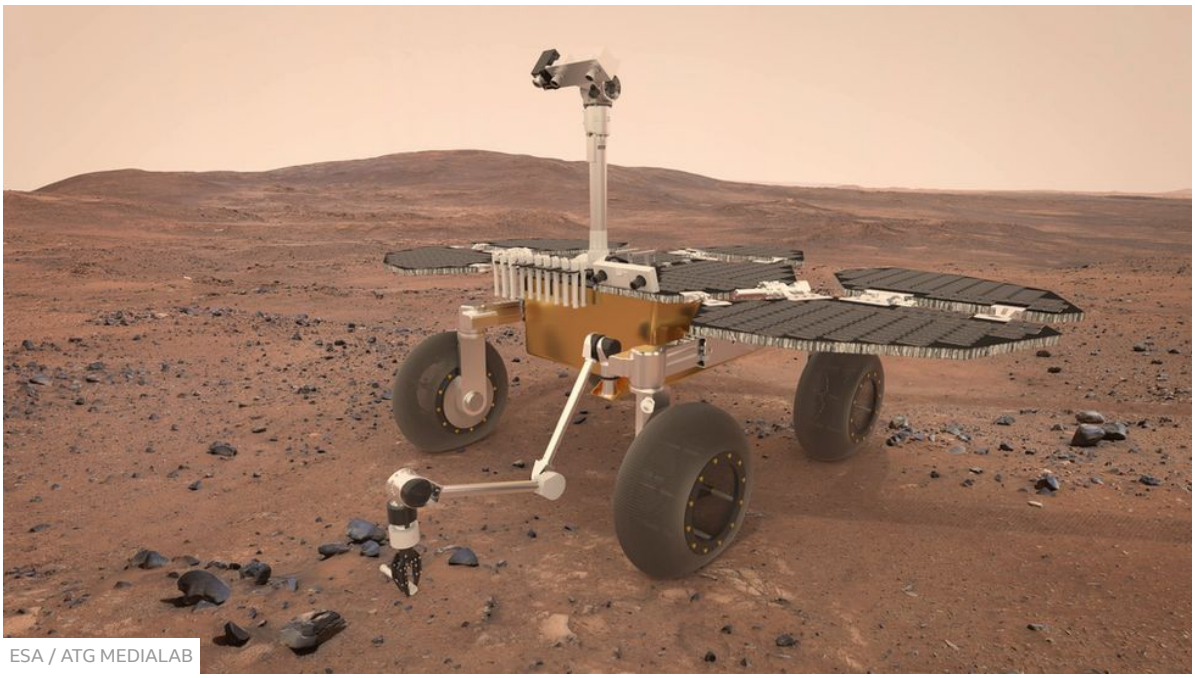
How does the rover store rocks and soil?

The rover's Sample Caching System **is composed of three robotic elements**. The most visible is the 2.1m (7ft) -long, five-jointed robotic arm, which is bolted to the chassis. A rotary percussive drill on the arm's turret is able to cut out intact cores of Martian rock. These cores - about the size of a piece of

chalk - go into a sample tube. The main robot arm then places the filled tube on **a mechanism at the front of the rover** called the bit carousel.

This mechanism, which recalls a 1960s slide projector, moves the tube inside the rover where a smaller, 0.5m (1.6ft) -long sample handling arm (also called the *T. rex* arm) grabs it. An image is taken before the tube is hermetically sealed and placed in a storage rack. It's driven around on the rover until the team finds a suitable place to drop it off.

How will the Martian samples be delivered to Earth?



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Artwork: The plan foresees a "fetch" rover being despatched to collect the sample containers

For decades, scientists have wanted to deliver samples of Martian rock and soil to Earth for study in laboratories. Here, scientists could investigate the samples with instruments too large and complex to send to Mars. By leaving rock and soil samples on the surface in sealed tubes, Perseverance will lay the groundwork for that to happen.

- **Bringing Mars back to Earth**

As part of the programme known as Mars Sample Return, a separate mission will be sent to land on Mars to pick up the tubes using a "fetch" rover. A robotic arm will then transfer the tubes from the fetch rover into a rocket called the Mars Ascent Vehicle (MAV). The ascent vehicle blasts the samples into Martian orbit where they are captured by an orbiter. This orbiter will then deliver the sample containers to Earth, possibly by 2031.

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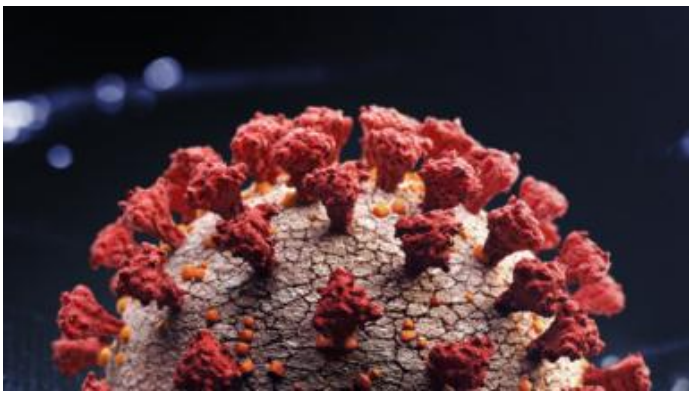

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