

# ROBOT

# ROLLERS

Meet the robotic explorer ready to embark on a new mission to Mars.

## DID YOU KNOW?

The Perseverance rover was named by a 13-year-old boy called Alexander Mather, and Ingenuity got its name thanks to a 17-year-old girl called Vaneeza Rupani.

An artist's impression of the Perseverance rover on Mars.

**T**his summer, a rocket will blast off from Cape Canaveral, Florida, US, on a very special mission. On board the rocket will be the US space agency NASA's new Perseverance rover, an advanced robot explorer that will travel millions of miles across the solar system to the planet Mars.

Packed with high-tech gadgets and gizmos – including a start-of-the-art drill that can collect rock and soil samples – Perseverance is the most

sophisticated scientific instrument ever to be sent to another planet. Slung underneath the robot roller is a mini helicopter called Ingenuity. This dinky drone will attempt the first powered flight on an alien world.

Engineers and scientists have been working on this project since 2014. Its goals are simple: to help scientists understand whether life once existed on the Red Planet; collect samples from the surface; and find

out whether people could visit Mars in the future. Hop on board with us to discover what will happen when Perseverance touches down on its new home on 18 February 2021.

## Meet the new rover

Weighing in at one tonne, Perseverance is about the size of a small car. It has six wheels, two microphones, 23 cameras and one giant 2.1-metre-long robotic





arm. In many ways, this robot explorer works like a human or a fictional droid, such as R2-D2 or WALL-E. With its microphones and camera it can hear the sounds of Mars and scan its surroundings. Its extendable arm can reach out and touch (and sniff) the world around it. The rover's three antennas act as its "voice", allowing it to send information to and receive data from Earth. The messages it sends will be relayed to and from the Martian surface via a network of orbiting satellites.

Perseverance also carries an entire laboratory on board to enable it to study the planet's geology (the materials that make it up), atmosphere and environment, and look for chemical clues of past life. Its gadgets include a ground-penetrating radar to peer beneath the surface, and a nifty laser to blast

dust from rocks and examine them from seven metres away.

### If it ain't broke...

Despite all of its shiny new kit, Perseverance doesn't actually look all that fresh. It shares its basic design with Mars's most famous robotic resident – NASA's Curiosity rover, which has been on the planet since 2012. Perseverance was built using some of the older rover's spare parts. Engineers spent a long time developing Curiosity's technology and since it



Mars is known as the Red Planet.

works so well, they are reducing the risk of things going wrong by keeping many of the same systems.

The new rover does have a few tricks up its robotic sleeves, however. Perseverance has bigger, beefed-up wheels, designed to grind over terrain as varied as loose sand and sharp rocks, without getting stuck or damaged. It can also do a bit of self-driving and steer away from possible dangers. This allows Perseverance to calculate a path five times faster than Curiosity. Perhaps the biggest difference between the



Perseverance's "eyes" are cameras mounted on a tall mast, plus a laser.

two rovers is the equipment mounted on the end of Perseverance's robotic arm. Rather than crushing rock samples like Curiosity, the rover carries a special drill to "core" rocks – just like removing the middle of an apple. These Martian rock samples will be sealed in tubes and left on the planet's surface. The hope is that a future mission could one day pick them up and carry them to Earth.

### Getting to Mars

Earth and Mars are planetary neighbours – the third and fourth planets from the Sun. However, as they travel around

the Sun, the distance between the two constantly changes. It can vary enormously – between 35 million miles and 250 million miles. As a result, space agencies only launch their spacecraft every few years, to take advantage of the times when the distance between the two planets is at its shortest.

Perseverance's journey begins aboard a powerful Atlas V rocket. After tearing through the sky and escaping Earth's gravity, the rover – nestled safely inside its protective spacecraft – will make a seven-month journey across the solar system to reach its final destination.

**DON'T TOPPLE OVER!**  
Perseverance is designed to climb 45-degree slopes without tipping over. To be safe, rover drivers avoid ground that tilts more than 30 degrees.

### Meet a Mars scientist

#### TANYA HARRISON PLANETARY SCIENTIST



##### What is your job?

I am what's called a geomorphologist. This is a really fancy way of saying I study the shapes of things on the surface of Mars, and how they are related to each other, to try and understand the history of what happened in a given place on the planet.

##### Why is Mars so exciting?

Mars is really cool because it's so much like Earth, and yet so different. It used to be much warmer, with lakes and rivers and a thicker atmosphere that could maybe have supported life. If it did have life, what happened? If it didn't, why didn't life form on Mars like it did on Earth?

##### What is your hope for the future of Mars exploration?

I really hope to see humans set foot on Mars in my lifetime. Our rovers are wonderful but they're still not a replacement for sending human scientists. I also can't wait to see a photo of humans standing next to one of the rovers we've sent before, showing how far we've come.

### Enter with style

Landing safely on the surface of Mars is extremely difficult (see the timeline). This is largely because Mars's atmosphere is roughly 100 times thinner than that of Earth. It is about the same thickness as the wispy air 22 miles up in Earth's sky. The major challenge of such a sparse atmosphere is that parachutes are of little use for slowing down a spacecraft as it descends. To complicate things further, the atmosphere on Mars is thick enough to cause friction, which means a spacecraft becomes incredibly hot as it heads towards the surface.

The team at NASA will borrow a technique that they used to land Curiosity in 2012. At that time, it was totally untried, pretty complicated and it seemed crazy. Scientists and engineers called it the "seven

### Hits and misses

Space agencies have been launching spacecraft to the Red Planet since the 1960s, but so far only NASA has been successful in getting its hardware safely to the surface. Around half of the spacecraft sent to Mars have crash-landed. Some people believe that the planet is cursed.



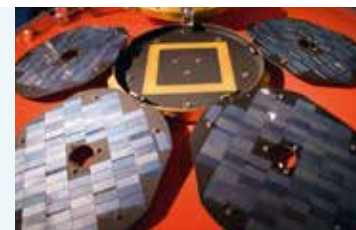
**1965** NASA's Mariner 4 takes the first close-up photo of the planet from a distance of around 200 miles away.



**1976** Viking 1 and 2 become the first landers to survive on the surface and send back images from the Red Planet.



**1993** NASA's Mars Observer mysteriously disappears before reaching orbit around Mars.



**2003** The European Space Agency's Beagle 2 makes it to the surface, but not all of its solar panels deploy.



**2004** NASA's twin rovers Spirit and Opportunity land on Mars. Opportunity works on the planet for 15 years.



**2012** NASA's Curiosity Rover is the largest and most advanced robot ever to operate on another world.

### THE ROBOT PLANET

Mars is the only planet in the solar system that is entirely occupied by robots. There are currently four robot rovers on the surface, but only one that works.



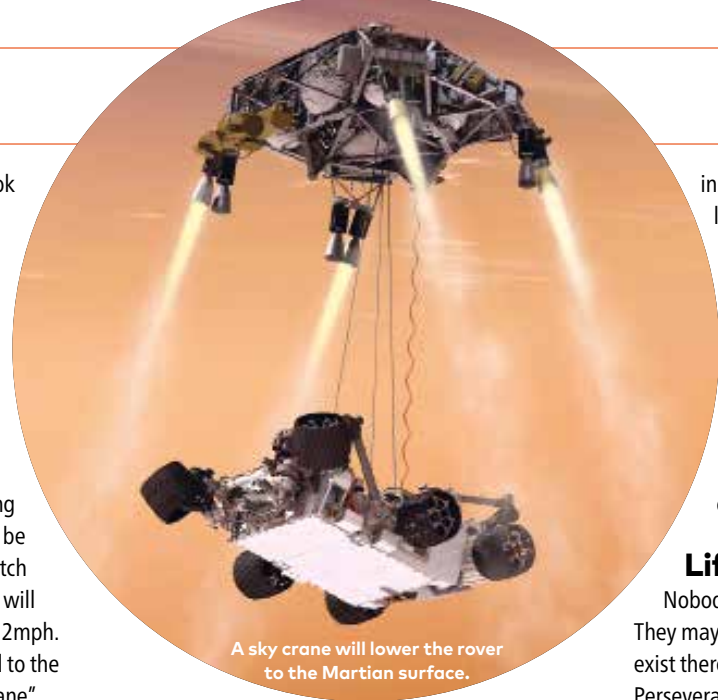


# SPACE

minutes of terror”, referring to the time it took for the rover to drop from the top of Mars’s sky to the surface.

On the day it lands, Perseverance will slam into the Martian atmosphere travelling at 13,000mph. Friction from the thin air will toast the spacecraft’s heat shield, heating it to 1,600°C and making it glow white-hot. Seven miles off the surface, a giant parachute will open, the heat shield will pop off, and the radar landing system will switch on. Perseverance will still be falling too fast to land at this point, so it’ll ditch its parachute and fire reverse rockets. These will help to slow the craft until it is falling at just 2mph. Then, the heavy rover will be gently lowered to the bottom of the crater from a hovering “sky crane”. Finally, the tether will be cut and the sky crane will zoom off so that it doesn’t land on top of the rover.

During this nail-biting period, Perseverance will be out of contact with mission control on Earth, because it takes 14 minutes for communications to travel between Mars and Earth. The team will just have to sit tight and wait for the signal that it has touched down safely.



A sky crane will lower the rover to the Martian surface.

in the solar system, Mars is the one most like Earth. Both are rocky worlds of the inner solar system. Both are governed by seasons and have been shaped by volcanoes and running water. Also, they are relatively close together. It is hoped that humans could adapt to life there in years to come. However, the root of the everyone’s fascination with Mars – and the biggest question of all – is did life ever exist on the planet?

## Life on Mars

Nobody knows if there are things living on Mars. They may have existed in the past and might even exist there today. One of the things that makes Perseverance so exciting is that it is the first rover designed with the specific purpose of looking for signs of life. Curiosity focused on whether the planet had ever had the conditions for life to exist. Researchers know water is the key to life; their motto is “Follow the water” in their search for signs of extraterrestrial lifeforms. Perseverance is being dropped in an area known as the Jezero Crater. This fascinating 28-mile-wide crater is believed to have

## Why go to Mars?

If you think that this plan sounds packed with potential problems, you are not wrong. Why would you risk a multi-billion-dollar space vehicle on such a complex and unlikely sounding set of manoeuvres? Well, because it’s worked once before, and because the rewards are worth the risk. Of all the planets

## IN THIN AIR

Helicopters on Earth rotate their blades about 500 times per minute. In Mars’s thin air, Ingenuity has to whizz its rotors around 2,500 times per minute.



An artist’s impression of the Ingenuity helicopter.



# MARS ROVER

## WOW!

To return to Earth, human explorers on Mars will need about 30–45 tonnes of oxygen fuel – about the weight of a Space Shuttle.



Will humans ever walk on Mars?

once been the site of a lake that has disappeared, and the Mars explorer will scour the area for chemical evidence left by living and long-dead organisms.

At the moment, the only planet on which life is known to exist is Earth. However, if Perseverance found enough evidence to show that there was life on Mars in the past (or even that there is still life there), that changes everything. Our planet would no longer be alone in the universe. If scientists could show that the living things on Mars are different to life on Earth – for instance, not based on DNA (the complex chemical molecule that carries instructions for making and maintaining all organisms on Earth) – it would show that life has arisen independently on two planets within our small solar system. This would suggest that in the wider universe – on the trillions of planets in space – we could well find other extraterrestrial life.

## A high flier

Perseverance’s mission is designed to last one Martian year (about 687 Earth days), although – like the Spirit and Opportunity rovers – it could go on for longer. It isn’t staying put on the ground, either. Hitching a ride beneath Perseverance’s belly is a robotic

companion – a helicopter named Ingenuity. This tiny 50-centimetre-high chopper weighs just 1.8 kilograms and has a very special mission. With its dual rotors spinning in opposite directions, Ingenuity will be the first vehicle ever to attempt a powered flight on another world.

The “marscopter” will try five flights. Each will last just 90 seconds and travel around 300 metres, flying up to five metres off the ground. It will have to fly on its own because the delay in communications between mission control and Mars makes remote control impossible. Ingenuity will not try to do any science; instead, its purpose is to show that powered flight is possible in the thin Martian atmosphere. Future missions could include more advanced helicopters that travel further, scout out sites for the ground-based rovers, gather samples and take high-resolution photos.

## A second home in space

Although Mars is not the closest planet to us (that title goes to Venus) it has the friendliest conditions for humans – so long as they wear a spacesuit. In the next few decades, astronauts might be able to travel to Mars and

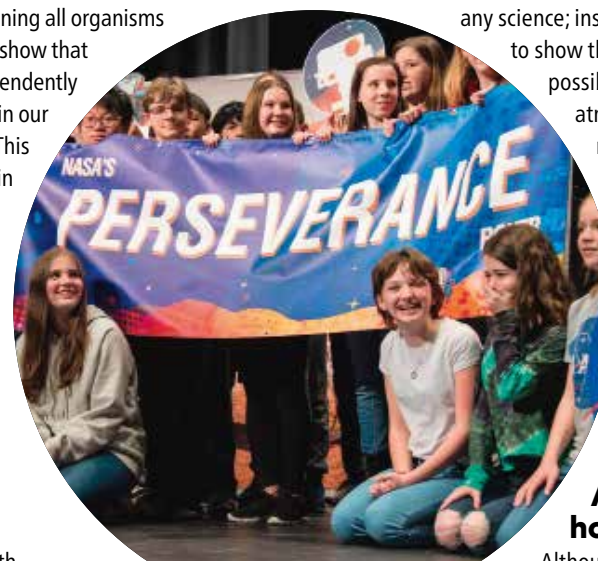
become the first people to walk on another planet. For this ever to be more than a dream, however, humans will need to make their own oxygen. This gas is essential, both for humans to breathe and to burn rocket fuel for the journey home. Carrying all that weight from Earth is just not practical.

Perseverance has one final marvellous piece of machinery called Mars Oxygen In-Situ Resource Utilisation Experiment – MOXIE, for short. This is a ground-breaking experiment that will test new technology that might help future human explorers. MOXIE will produce oxygen from the Martian sky like plants do on Earth.

## Red Planet’s secrets revealed

Mars is a place that hides the answers to some of the biggest questions in science. Researchers have lots of questions, but very few answers. For example, how did life arise on Earth? Could it have been brought to our planet on a meteorite from Mars?

NASA’s Perseverance rover mission will be another step to discovering more about this fascinating planet. Even more importantly, though, the mission will show everyone back on Earth new parts of Mars up close. It will give people new views of this distant rusty-red world, with its lovely pink sky and blue sunsets. It will give young people something to dream about. Humans might be seeing these scenes with their own eyes in just a few short decades. Just think – the first person to walk on Mars is probably still at school, not yet aware that one day they will join Perseverance on a planet that we’re only just beginning to study properly. Who knows? It could be you.



Pupils of Lake Braddock Secondary School, US, won a contest to name the new mission.