Mars Missions and the Science of the Red Planet

History of Mars Missions

When was NASA's first attempted mission to Mars, and what happened to it?
It was Mariner 3 in 1964. The launch failed. The next one was Mariner 4 just a few weeks later and it did a successful flyby. NASA also sent Mariner 6 and 7 in 1969 and they did successful flybys.

What was the first spacecraft to orbit another planet?
This was Mariner 9 from NASA, launched May 30, 1971. Interesting thing is the Russians also successfully orbited Mars with their spacecraft. Mariner 9 entered orbit around Mars November 14, 1971, then the Russian spacecraft (called Mars 2) entered orbit just 13 days later Nov. 27, 1971. The Russians also tried to land on Mars (5 spacecraft after Mars 2 from 1971 to 1973) but they had trouble with their landers.

Viking 1 & 2 - Launched in August and Sept. 1975.
Viking 1 lander successfully landed on Mars July 20, 1976 (summer after I graduated from High School). Viking scooped up soil and did chemical tests on it. Took good pictures of the surface.

In which NASA mission to Mars was the spacecraft lost after it reached Mars?
Mars Observer. Launched Sept. 25 1992. It never made it into orbit. Communication with it was lost.

Mars Global Surveyor
Launched Nov. 7, 1996. Successfully orbited Mars for 7 years.

Mars Pathfinder & Sojourner
Launched Dec. 1996. Sojourner landed July 4, 1997; operated for 84 days. Considered the first successful rover to operate on another planet.

Nozomi (Japan)
Japan attempted to do a flyby of Mars with their Nozomi spacecraft, launched in July 1998. The spacecraft did a brief flyby but was lost. Japan actually had two separate space agencies but they merged together in 2003 into the Japan Aerospace Exploration Agency or "JAXA". JAXA has had limited success with rockets and putting small satellites in Earth orbit.

2 Failed NASA Missions to Mars
In 1998 NASA launched the Mars Climate Orbiter and after this the Mars Polar lander/Deep Space 2 "Penetrator" in January 1999. The Deep Space 2 penetrator was supposed to hit the Mars surface at high speed (590 ft/sec) and it had a probe that was supposed to penetrate 2 ft into the soil. But it failed to send any data, so it apparently didn't survive. The Climate Orbiter was supposed to relay communications from the Mars Polar Lander. But it never made it into orbit. Engineers found out the problem stemmed from different systems not having accurate measurements due to one part using metric units (from NASA) and another part using english units (from Lockheed Martin)!

Longest Operating Spacecraft at Mars - Mars Odyssey
On April 7, 2001 the Odyssey spacecraft was launched from Earth and it reached Mars orbit October 24, 2001. Odyssey has become the longest surviving operating spacecraft at any planet other than Earth (having operated for over 19 years). In fact, it is still operational today (June 2021) and is expected to

continue until it runs out of fuel in 2025. Odyssey has gathered important data about what the surface is made of and about hydrogen and ice present under the Martian surface. Mars has regions around it's equator that have large amounts of water ice under the surface. This was discovered by Odyssey.

Mars Express and Beagle 2 (ESA)
The European Space Agency had a mission to Mars called Mars Express, which launched in June 2003. This spacecraft launched with a Russian rocket. The orbiter has successfully orbited Mars to the present time. However, the Beagle 2 lander never communicated with the spacecraft and had trouble with its solar panels.

Spirit and Opportunity
These were launched by NASA in June (Spirit) and July (Opportunity) of 2003. They both landed rovers that successfully operated on Mars beginning in January 2004. These rovers were both stuck in soft sand and could not extricate themselves but they explored craters and various Martian rocks.

Mars Reconnaissance Orbiter (MRO)
NASA Launched the MRO in August 2005 and entered Mars orbit in March of 2006. This spacecraft still operates in Mars orbit. MRO still provides a high speed data relay for sending data to Earth and valuable information about Mars surface and weather. It has been critical for choosing landing sites for multiple missions that came after it.

Phoenix
This was a lander mission. It landed successfully on Mars in May 2008 and ended its mission later in November of that year. The mythical bird called the Phoenix inspired the name of this mission. The Phoenix lander was not a rover but landed not far South of Mars' North pole region, in what's called the Vastitus Borealis, the Northern Lowlands (this region is a mystery - why it is low elevation). It was hoped that Phoenix would survive the Martian winter but it lost power. Still it met all the mission objectives. It had some interesting instruments including two types of microscopes. It also had a special tool that could cut into the frozen soil.

Mars Science Laboratory (MSL) and Curiosity
This launched from NASA in November 2011 and the Curiosity rover landed on Mars in August 2012. This mission was the first to use what has been known as the "sky-crane" maneuver for landing the rover. There is a descent unit that is like a basket that holds the rover folded up below it. The descent unit has small rockets on it that fire during landing and as it approaches the surface, the rover unfolds its wheels and is let down on cables. Then when the rover touches down on the surface the descent unit flies off. The Curiosity rover is still in operation today and is packed with scientific instruments. It is also made to be "hardened" against radiation and it measures radiation on Mars both during landing and after landing. It collected a lot of data to understand what astronauts would face in the future when astronauts go to Mars.

Quoted from Wikipedia: https://en.wikipedia.org/wiki/Curiosity_(rover)

'A NASA panel selected the name Curiosity following a nationwide student contest that attracted more than 9,000 proposals via the Internet and mail. A sixth-grade student from Kansas, 12-year-old **Clara Ma** from Sunflower Elementary School in Lenexa, Kansas, submitted the winning entry. As her prize, Ma won a trip to NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, where she signed her name directly onto the rover as it was being assembled.[22]

Ma wrote in her winning essay:

"Curiosity is an everlasting flame that burns in everyone's mind. It makes me get out of bed in the morning and wonder what surprises life will throw at me that day. Curiosity is such a powerful force. Without it, we wouldn't be who we are today. Curiosity is the passion that drives us through our everyday lives. We have become explorers and scientists with our need to ask questions and to wonder." '

MAVEN
This NASA mission's name is an acronym for *M*ars *A*tmosphere and *V*olatile Evolutio***n***. It left Earth in November of 2013. It's purpose was to study the effects of the solar wind at Mars and the escape of Mars' atmospheric gases into space. It studied the escape of carbon, oxygen, and hydrogen into space in order to learn about long term changes in Mars' atmosphere. (This gets at the question of how could Mars have had liquid water on the surface in the past?) MAVEN is also still operational today.

Mars Orbiter Mission (or Mangalyaan)
In November 2013 Indian Space Research Organization (ISRO) launched India's first interplanetary space mission. Since September 2014 Mangalyaan has been orbiting Mars. The Mangalyaan spacecraft is in an elliptical orbit around Mars that makes it nicely placed to obtain some very nice photos of Mars. NASA also provided some communication and navigation support. There is also some coordination between the MAVEN mission from NASA and Mangalyaan.

ExoMars 2016 (ESA & Russia)
This mission was originally a NASA concept but then for a time was planned to be a joint project between NASA and the European Space Agency (ESA). Then budget cuts at NASA led to NASA bowing out. So, ESA partnered with the Russians. It consisted of the ExoMars Trace Gas Orbiter and a lander called Schiaparelli. The Trace Gas Orbiter looked for methane and other gases that could be signs of life related molecules. The Orbiter entered orbit in October of 2016 and continues to operate today. But the lander crashed on Mars. Though the lander was destroyed in the crash, it did send some valuable data on its way down.

InSight and MarCO A & B
This was a NASA mission in 2018 with a lander, Insight, and two very small Mars satellites called MarCO A and MarCO B. The MarCO devices were small cubes with miniaturized communication and navigation equipment. Their job was to relay telemetry from the InSight lander while it was out of line-of-sight communication with Earth during its landing. All three reached Mars and the lander successfully landed. The MarCO devices only operated for about seven months. The lander was intended to drill instruments into the soil to do seismic measurements of Marsquakes and measure the heat given off from the Martian surface. The drilling probes did not work because the soil turned out to be too soft to drill into. But it was able to measure some Marsquakes in April 2019.

Emirates Mars Mission
The United Arab Emirates sent an orbiter called Hope to Mars, launching July 19, 2020 from a Japanese rocket. The Hope spacecraft entered orbit February 9, 2021 and it is still operating today.

Tianwen-1 and Zhurong (China)
This Chinese mission launched from a large Chinese rocket July 23, 2020 and entered orbit around Mars February 10, 2021. The Tianwen-1 has an orbiter and a lander, accompanied by a rover called Zhurong. All three devices have been successful on Mars and are still operational. The rover was deployed May 22, 2021. This is China's first successful rover on another planet.

Mars 2020 - Perseverance & Ingenuity
In July 2020 the Mars 2020 mission was launched from Florida. It landed on Mars in February 2021. Ingenuity is a small robotic helicopter that made the first flight in the atmosphere of another planet on April 19, 2021. Perseverance carries with it a variety of cameras and instruments for looking for possible places microbial life may have existed in the past. It also collects core samples from rocks and uses a variety of high tech instruments to look for organic material. Perseverance also successfully tested a new method for generating oxygen from the Martian atmosphere. This method could possibly be used in the future in human exploration of Mars. Videos and pictures of Mars from Perseverance and Ingenuity have captured the attention of many.

Scientific Mysteries at Mars

- How is it that liquid water existed on Mars' surface in the past?
- Was there ever life on Mars?
- Were there lakes on Mars in the past?
- Why is the Northern lowlands low elevation?
- How have the rocks on Mars formed?

Links for more exploration:

4 Minute exciting video showing how far NASA has come in the progression of all the Mars missions
https://mars.nasa.gov/resources/20289/50-years-of-mars-exploration/

Wikipedia page listing all missions to Mars, from all nations
https://en.wikipedia.org/wiki/List_of_missions_to_Mars

On Perseverance's landing. Seven minutes to Mars (Feb 12, 2021)
https://www.youtube.com/watch?v=M4tdMR5HLtg

Actual footage of landing from the Descent Module and the lander
https://www.youtube.com/watch?v=4czjS9h4Fpg

This is the NASA Mars Exploration Program website. Lots of articles, pictures, videos on all the NASA missions to Mars.
https://mars.nasa.gov/mars-exploration/missions/