

Mars Background Information

General Information

Here are some quick facts about Mars in comparison with Earth:

	Mars	Earth
Atmosphere	95% CO ₂ , 5% N ₂ , Ar & trace gasses 0.007 atm pressure	78% N ₂ , 21% O ₂ , 1% trace gasses 1 atm pressure
Gravity	3.7 m/s ²	9.8 m/s ²
Calendar	24.6 hr day (sol) 687 sol year 4 seasons	24 hr day 365.25 day year 4 seasons
Moons	2 (Phobos and Deimos)	1 (Luna)
Terrain	More topographic relief than Moon or Earth Elevation range: +27 km (Olympus Mons) to -4km (Hellas Basin) No Liquid water Polar Ice caps Negligible magnetic field	Elevation range: +8.9 km (Mount Everest) to -11 km (Mariana Trench) 70% water Polar Ice caps

Mission Timeline

<u>Mission</u>	<u>Date</u>	<u>Accomplishment</u>
Mariner 4	7/14/65	First successful fly-by
Mariner 9	11/71 - 10/72	Orbit of Mars
Viking 1&2	6/76 - 1987	Orbiter and First lander on Mars
Mars Global Surveyor	9/97 -	Science mapping of Mars
Mars Pathfinder	7/97 - 9/97	First rover on Mars
Mars Odyssey	4/01 -	Discovered water!
Mars Exploration Rovers		Currently En Route

There were several flybys of Mars during the Mariner Program. These spacecraft returned the first pictures of Mars up close. Not until the Viking Missions was anything successfully landed on Mars. Viking conducted tests on the surface to determine if there was life on Mars. The tests were inconclusive. Mars Pathfinder and the Sojourner Rover were the first mission to move around on the surface of Mars. Mars Odyssey has perhaps returned the most exciting news from Mars, the possibility of sub-surface water. This water may be as close to 1m below the surface. This finding allows for more flexibility in mission planning for a human mission. If there is water near the

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surface, it may be mined for use as fuel, oxygen or potable water. The Mars Exploration Rovers are will look for evidence of liquid water on the surface in the past, as well as find the composition of rock and soil samples of the Martian surface.

Engineering Challenges

Mars has several engineering challenges that must be faced before a human mission to the planet will be successful. These challenges include: dust, radiation, atmosphere, and terrain.

Dust

Dust on Mars poses an interesting challenge for engineering technology to use on the surface. The dust on Mars is microscopically small, highly abrasive, and electro-statically charged. Similar to the Moon, this dust can degrade seals and mechanical linkages. Because of the electro-static attraction the dust will also stick to electronic equipment. Solutions have been posed to this problem. It is possible to apply a charge to the surface of solar panels, for example. The dusts attraction is then broken and falls off. The same could be done for the windows on a pressurized rover, a modified windshield wiper could also be used.

Atmosphere

The atmosphere on Mars is mostly carbon dioxide and at very low pressure. This poses several problems for explorers on Mars. First, oxygen will have to be brought whether fuel cells or internal combustion engines are used. Secondly, the small atmosphere does not allow for efficient heat transfer. With such low pressure, the only mode of heat transfer available is radiative. Radiative heat transfer is quite small. So even though Mars is much colder, most equipment will have to be cooled.

Radiation

Due to the thin atmosphere the radiation levels on the surface of Mars are quite high. Creative solutions will be needed to protect the astronauts from radiation exposure.

Terrain

Mars has widely varied terrain. Primary challenges include dust, loose rocks, large rocks, steep slopes, and narrow canyons. Rovers should be designed with very low centers of gravity to enable traverse up steep slopes. Rovers

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should also have suspension that allows smooth travel over rough terrain. Rovers should have steering and control that allows maneuverability on uneven surfaces and in tight spaces.

Gravity

The coefficient of friction depends on the gravitational constant. Lower gravity on Mars means that braking and turning will be more difficult than on Earth. On Mars it will take longer to stop and vehicles will have to turn very slowly to avoid slipping.

Mission Architecture

Orbital dynamics limit the available launch windows for Earth-Mars and Mars-Earth trajectories. The lowest cost trajectories allow either a 30 day or a 500 day stay on the surface of Mars. Landing sites will most likely be near the equator. The equator is the easiest place to land, from a trajectory perspective, and provides access to the greatest variety of terrain on Mars.

A crew will stay at a permanent facility in one location and use rovers for traveling to scientifically interesting locations. Mission architecture elements that will affect all aspects of mission design include the total number of crew, science goals, length of stay, life support recycling capabilities, and power sources.