THE MISSION

You are responsible for a mission to place the first humans on Mars for a period of 18 months (not including flight time).

You will be responsible for who goes, what you take, where you live, and the ultimate survival of your crew.

We will test your preparations and planning against real-world challenges on Mars (also known as the red planet), so plan carefully, and safe travels!

FOREWARNED

As the saying goes, **forewarned is forearmed** (from the latin *praemonitus, praemunitus*) , which means that what you know can help you. Increase what you know about Mars to improve your mission preparations.

Martian sol: 24.63 hours (23.94 hours on Earth)
Martian year: 687 days (365 on Earth)
Surface area: 28.4% of Earth (less than all the dry land on Earth (29.2%))

- **No Life.** Earth-originated plants and animals would not be able to survive the ambient conditions on the surface of Mars.

- **Gravity.** Gravity on Mars is approximately 1/3 of that on Earth (38%), so plan for medical issues like balance disorders, cardiovascular deconditioning, muscle atrophy, and bone loss.

- **Dust.** The dust on Mars is toxic (due to the presence of perchlorates, which are hazardous to all known forms of life), finely grained (which is unhealthy for lungs and eyes), and abrasive. Dust storms are common, can last for weeks, and the dust remains suspended for months, reducing solar generation. Minimizing the dust that enters the habitat, and critical equipment, will pose a significant challenge.

- **Distance.** The ideal window to travel to Mars occurs every two years, and even then the trip takes five to ten months. Nobody is coming to the rescue while you are there, so make sure that you are prepared to take care of yourselves. For periods of several weeks, you won't be able to call for help, either, and when you do have communication with Earth, the delay will be up to 45 minutes per transmission.

- **Atmosphere.** Humans cannot breathe the air which is 95% carbon dioxide, 3% nitrogen, 1.6% argon, and 0.4% other (compared to 78% nitrogen, 21% oxygen, 1% other on Earth).

- **Atmospheric pressure.** People cannot survive outdoors without pressure suits for any span of time, or indoors without pressurized spaces, due to the thin atmosphere.

- **Radiation.** Mars has a very week magnetosphere and its atmosphere is 100 times thinner than Earth's atmosphere, increasing your crew's radiation exposure 4 times more than what they experience on Earth. Your crew will also be exposed to 9 times more radiation in transit, creating the possibility of radiation-related health problems before they even arrive. To minimize radiation exposure, consider building underground, or in old lava tubes, which would also protect your crew from meteoroid and micrometeoroid impacts and the planet's temperature fluctuations.

- **Psychology.** One of the habitats being considered is 28 feet high, 28 feet wide, and 17 feet long (smaller than half a tennis court), which is a very small space! Plan for people having trouble adjusting to tight quarters, and long periods inside.

- **Weight matters.** Every ounce that goes to Mars costs fuel to get it there, so you need to be careful to minimize anything extra, as your rockets have very real limitations.

- **Water.** If you stay near the poles, you will have access to frozen water, saving you from shipping water (which is very heavy at the quantities you will need!), and it can also be used to create oxygen (via electrolysis), which would save the weight of bringing oxygen, as well. The poles, however, are extremely cold, and the temperature can drop to minus 243 Fahrenheit (minus 153 Celsius).

YOUR CREW

Who are you bringing? Get specific. What are their ages, specializations, and strengths?

HABITAT

Where will you live? What will your habitat look like? How will you protect your crew from the physical risks on Mars?

TESTS

Thought experiments (LINK), like these, are a great way to evaluate planning, and to look for edge cases (LINK). Discuss the likely consequences of each test. Rather than deciding if your preparations were "right," use the tests and discussed possible consequences to see how your preparations can be *improved*. Also, come up with your own tests!

- **Test 1.** A meteoroid shower occurs in the area of your habitat. Did your planning protect your crew?
- **Test 2.** Dust storms encircle the planet, and your crew must stay indoors with diminished power generation for over a month. Did your planning protect your crew both from a physical and psychological perspective?
- **Test 3.** A Solar Particle Event occurs, showering the planet with intense radiation. Did your planning protect your crew?
- **Test 4.** The food supplies sent ahead were contaminated due to a rough impact, and are unusable. Did your plan food contingencies?
- **Test 5.** Some of your freeze-dried food was not freeze-dried correctly, creating contamination, and the entire crew is now incredibly ill. Did your planning involve a medical doctor?
- **Test 6.** Your pilot suffered an accident shortly before your planned return trip, and cannot pilot your ship. Is anyone on your crew cross-trained for that critical position?

NEXT STEPS

Your Mars expedition will create questions and possibilities. Learn more and think about:

- How would you expand the initial human presence on Mars to create a *sustainable* human presence?

- What governance system would you set up for the Martian residents? What would their relationship be with Earth? What *should* it be?

- Typically, we sterilize objects going into space to prevent contaminating the environments they visit, but humans have a microbiome filled with a hundred trillion microorganisms. *Should* we risk contaminating Mars?

- Mars could be a stepping stone to the asteroid belt, which is filled with untold mineral riches. How could Mars be used to make the asteroid belt more accessible? *Should* humans mine the asteroid belt?

- What does the mission to Mars tell us about what would be needed to reach Alpha Proxima, our next-nearest star. It would take over 6,000 years to reach it at our current traveling speeds. What would a mission to Alpha Proxima look like? Would you volunteer to go?

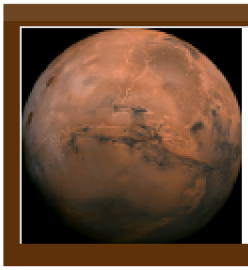
- Should we be colonizing Mars, or should we focus on the option closer to home: The Moon. What are the arguments in favor of each?

RESEARCH

Want to learn more? Go for it!

Colonization of Mars

Colonization or settlement of Mars is the theoretical human migration and long-term human establishment of Mars. The prospect has garnered interest from...



Videos

NASA's real-time portal for Mars exploration, featuring the latest news,...

mars.nasa.gov

The Danger of Going to Mars

Many spacecraft have died trying to get to Mars. The current record for Mars...

nasa.gov

Human Mars Exploration and Expedition Challenges

Malaya Kumar Biswal M and Ramesh Naidu Annavarapu

LINK

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