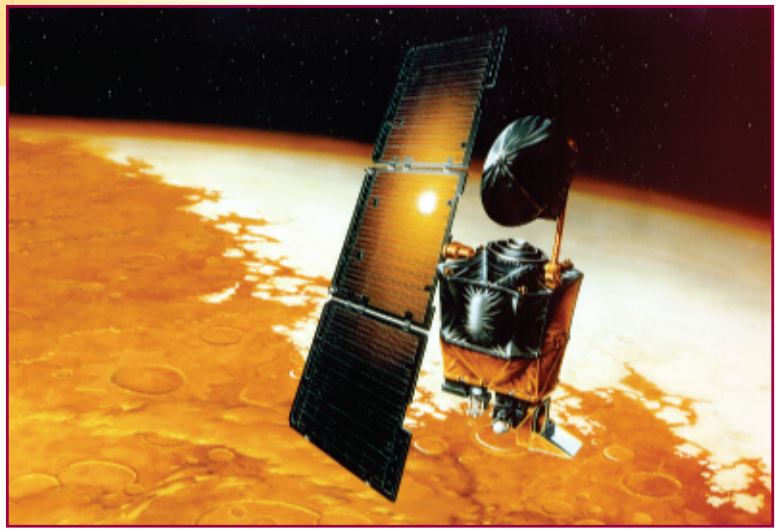
Why it Matters

The Mars Climate Orbiter Mission



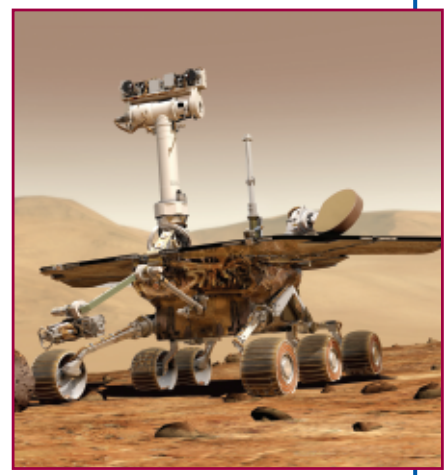
The $125 million Mars Orbiter mission failed because of a miscommunication about units of measurement.

The *Mars Climate Orbiter* was a NASA spacecraft designed to take pictures of the Martian surface, generate daily weather maps, and analyze the Martian atmosphere from an orbit about 80 km (50 mi) above Mars. It was also supposed to relay signals from its companion, the *Mars Polar Lander,* which was scheduled to land near the edge of the southern polar cap of Mars shortly after the orbiter arrived.

The orbiter was launched from Cape Canaveral, Florida, on December 11, 1998. Its thrusters were fired several times along the way to direct it along its path. The orbiter reached Mars nine and a half months later, on September 23, 1999. A signal was sent to the orbiter to fire the thrusters a final time in order to push the spacecraft into orbit around the planet. However, the orbiter did not respond to this final signal. NASA soon determined that the orbiter had passed closer to the planet than intended, as close as 60 km (36 mi). The orbiter most likely overheated because of friction in the Martian atmosphere and then passed beyond the planet into space, fatally damaged.

The *Mars Climate Orbiter* was built by Lockheed Martin in Denver, Colorado, while the mission was run by a NASA flight control team at Jet Propulsion Laboratory in Pasadena, California. Review of the failed mission revealed that engineers at Lockheed Martin sent thrust specifications to the flight control team in English units of pounds of force, while the flight control team assumed that the thrust specifications were in newtons, the SI unit for force. Such a problem normally would be caught by others checking and double-checking specifications, but somehow the error escaped notice until it was too late.

Unfortunately, communication with the *Mars Polar Lander* was also lost as the lander entered the Martian atmosphere on December 3, 1999. The failure of these and other space exploration missions reveals the inherent difficulty in sending complex technology into the distant, harsh, and often unknown conditions in space and on other planets. However, NASA has had many more successes than failures. A later Mars mission, the Exploration Rover mission, successfully placed two rovers named *Spirit* and *Opportunity* on the surface of Mars, where they collected a wide range of data. Among other things, the rovers found convincing evidence that liquid water once flowed on the surface of Mars. Thus, it is possible that Mars supported life sometime in the past.



The *Spirit* and *Opportunity* rovers have explored the surface of Mars with a variety of scientific instruments, including cameras, spectrometers, magnets, and a rock-grinding tool.