

## 2.1: The Metric Mix-up - A \$327 Million Unit Error

Small errors in these unit systems can sometimes harbor massive ramifications. Although NASA declared the metric system as its official unit system in the 1980s, conversion factors remain an issue. The Mars Climate Orbiter, meant to help relay information back to Earth, is one notable example of the unit system struggle. The orbiter was part of the Mars Surveyor '98 program, which aimed to better understand the climate of Mars.

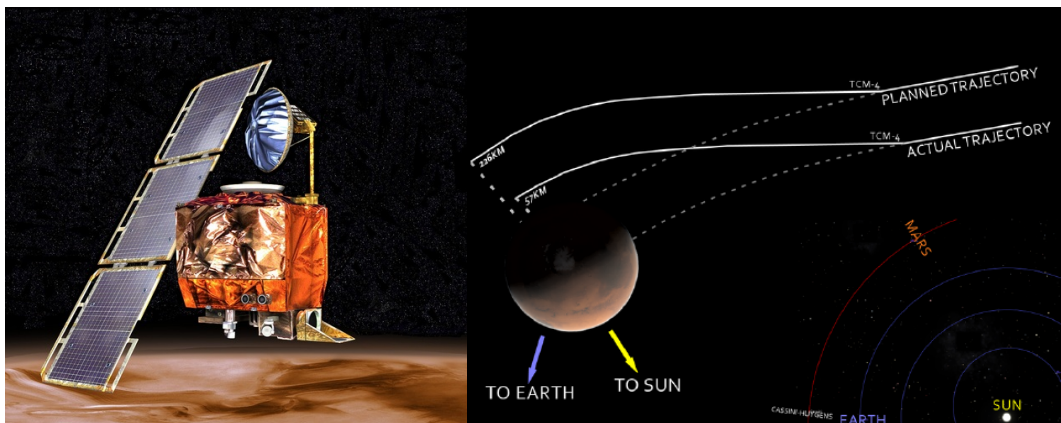


Figure 2.1.1: (left) The Mars Climate Orbiter, (Public Domain; NASA/JPL-Caltech). (right) Diagram of the mishap during the Mars Climate Orbiter mission that resulted in the loss of the spacecraft. (CC BY-SA 3.0; [Xession](#) via [Wikipedia](#))

As the spacecraft journeyed into space on September 1998, it should have entered orbit at an altitude of 140-150 km above Mars, but instead went as close as 57 km. This navigation error occurred because the software that controlled the rotation of the craft's thrusters was not calibrated in SI units. The spacecraft expected newtons, while the computer, which was inadequately tested, worked in pound-forces; one pound force is equal to about 4.45 newtons. Unfortunately, friction and other atmospheric forces destroyed the Mars Climate Orbiter.

Clearly, the 4.45-fold difference between the newtons and foot-pound units is catastrophic for space exploration. The project cost \$327.6 million in total. Tom Gavin, an administrator for NASA's Jet Propulsion Laboratory in Pasadena, stated, "This is an end-to-end process problem. A single error like this should not have caused the loss of Climate Orbiter. Something went wrong in our system processes in checks and balances that we have that should have caught this and fixed it." As most advanced chemistry students can attest, properly using units are similarly critical in chemistry; failure to address them properly can have dire consequences.

2.1: The Metric Mix-up - A \$327 Million Unit Error is shared under a [CC BY-NC-SA 4.0](#) license and was authored, remixed, and/or curated by LibreTexts.