2013  2014
ONE MARTIAN YEAR • TWO EARTH YEARS
A Martian Year Each page of the calendar has a diagram showing the relative positions of Earth and Mars on the first day of the month. If Mars is farther from the Sun compared with Earth, so it takes Mars longer to complete one orbit and its year is longer than an Earth year. A Mars year is 687 Earth days long — almost two Earth years. This calendar covers one Martian year and two Earth years.

A Martian Day Like Earth, Mars rotates on its axis, but more slowly, so a Martian day is slightly longer than an Earth day. The Mars day (sol) is 24 hours, 39-1/2 minutes long. This calendar tracks how many sols have passed since Opportunity (designated “B” in red type) and Curiosity (“C” in blue type) landed on Mars. (Spirit had the “A” designation while it was in operation.) About every 36 days the calendar skips an Earth day in counting sols, so days and sols can stay synchronized.

Day of the Year Each calendar square representing a day has a number in the top right corner indicating the consecutive day of the year (DOY). Space mission operations typically use DOY as a shorthand way of showing the date.

DSN Week Number This number helps all operating deep space missions schedule use of Earth-based antennas in the Deep Space Network (DSN). DSN Week 1 began on the first Monday of the calendar year and is numbered sequentially to the end of the year.

Mars Seasons Mars solar longitude (the Ls, number on the first day of each month in the calendar) determines seasons on Mars. As Mars travels around the Sun through 360°, it experiences seasons just as Earth does.

How to Use the Calendar

Cover Artist's concept of NASA's Mars Exploration Rover Opportunity and Mars Science Laboratory Curiosity.

Opportunity and its twin, Spirit, landed on opposite sides of Mars in January 2004, each with a planned mission of 90 Martian days (sols). Spirit lasted more than six years, entering operation March 24, 2004, and Sol 2210. As of December 2012, Opportunity moved onward nearly 22 miles (35 kilometers) for more than 3,100 sols, and continues to explore and communicate with Earth.

Curiosity landed on Mars August 6, 2012 (UTC) for a planned 23-month mission to investigate whether Mars ever had favorable environmental conditions (habitats) in support of microbial life.

Visit mars.jpl.nasa.gov

MARS EXPLORATION ROVERS • SPIRIT & OPPORTUNITY

Remote Sensing Instruments

- Panoramic Camera (Pancam) — Creates high-resolution color images with a stereoscopic camera pair that can rotate in a complete circle and look straight up and down.
- Miniature Thermal Emission Spectrometer (Mini-TES) — Analyzes infrared light to identify rock-forming minerals; measures atmospheric conditions (e.g., temperature and pressure). See color images with a stereoscopic camera pair that can rotate in a complete circle and look straight up and down.
- Mössbauer Spectrometer (MB) — Measures iron-bearing mineralogy of rocks and soils.
- Alpha Particle X-ray Spectrometer (APXS) — Measures the chemical composition of Martian rocks and soils.
- Chemistry and Camera (ChemCam) — Fires a laser to analyze chemical elements of vaporized minerals. See color images of the small-scale features of Martian rocks and soils.

Contact Science Instruments

- Rock Abrasion Tool (RAT) — Brushes and grinds rocks to clean away dust and other surface deposits so the spectrometers can analyze their composition.
- Alpha Particle X-ray Spectrometer (APXS) — Measures the chemical composition of Martian rocks and soils.
- Mössbauer Spectrometer (MB) — Measures iron-bearing mineralogy of rocks and soils.
- Microscopic Imager (MI) — Provides high-resolution images of the small-scale features of Martian rocks and soils.

Analytical Laboratory Instruments

- Chemistry and Mineralogy (CheMin) — Measures the chemical and isotopic composition of rocks, soils, and dust. See close-up views of minerals, textures, and structures in Martian rocks and in the surface layer of rocky debris and dust.
- Alpha Particle X-ray Spectrometer (APXS) — Measures chemical elements in rocks and soils in preparation for sample selection.
- Sample Analysis at Mars (SAM) — Measures the chemical and isotopic composition of rocks, soils, and dust. See close-up views of minerals, textures, and structures in Martian rocks and in the surface layer of rocky debris and dust.
- Mister塵 (MAD) — Took color video during the rover’s descent toward the surface; provides images of the ground beneath the rover.
- Dynamic Albedo of Neutrons (DAN) — Provides daily and seasonal weather reports (atmospheric pressure, humidity, ultraviolet radiation, wind, and ground temperatures).
- Chemistry and Camera (ChemCam) — Fires a laser to analyze chemical elements of vaporized minerals. See color images of the small-scale features of Martian rocks and soils.

Environmental Instruments

- Radiation Assessment Detector (RAD) — Measures high-energy radiation to understand if habitable conditions for microbial life or future human exploration are possible.
- Dynamic Albedo of Neutrons (DAN) — Detects water content as low as one-tenth of 1 percent in the Martian subsurface.
- Solar Wind Measurements (SAM) — Measures the chemical and isotopic composition of rocks, soils, and dust. See close-up views of minerals, textures, and structures in Martian rocks and in the surface layer of rocky debris and dust.
- Alpha Particle X-ray Spectrometer (APXS) — Measures chemical elements in rocks and soils in preparation for sample selection.
- Sample Analysis at Mars (SAM) — Measures the chemical and isotopic composition of rocks, soils, and dust. See close-up views of minerals, textures, and structures in Martian rocks and in the surface layer of rocky debris and dust.
- MSL CheMin — Measures the chemical and isotopic composition of rocks, soils, and dust. See close-up views of minerals, textures, and structures in Martian rocks and in the surface layer of rocky debris and dust.

Sample Analysis at Mars (SAM) — Measures the chemical and isotopic composition of rocks, soils, and dust. See close-up views of minerals, textures, and structures in Martian rocks and in the surface layer of rocky debris and dust.

Sample Analysis at Mars (SAM) — Measures the chemical and isotopic composition of rocks, soils, and dust. See close-up views of minerals, textures, and structures in Martian rocks and in the surface layer of rocky debris and dust.

Sample Analysis at Mars (SAM) — Measures the chemical and isotopic composition of rocks, soils, and dust. See close-up views of minerals, textures, and structures in Martian rocks and in the surface layer of rocky debris and dust.
This watermelon-sized rock discovered by Opportunity, called “Block Island,” is the largest meteorite yet found on Mars. It is rich in iron and nickel, similar to some meteorites found on Earth. As the meteorite came blazing in through Mars’ atmosphere, smooth, rounded holes formed on its surface. Once the meteorite was on the ground, long-term weathering created the large, irregular pit (right). Landing Block Island in today’s thin Martian atmosphere without disintegrating when it hit the ground is difficult. That means Mars once had a much thicker atmosphere or that the meteorite followed a rare, long, shallow flight path on its way down.
Each of the stacked layers in 3-mile-high Mount Sharp inside Gale Crater may preserve a record of the Martian environment at a given time in history. Curiosity will study each layer as it climbs. Lower layers contain minerals that formed in the presence of water (below dotted line). Some may preserve organics, the chemical building blocks of life. Top layers that incline sharply from left to right (above dotted line) likely formed under drier environmental conditions than those lower on the slope.

Using special filters on its camera “eyes” to make subtle differences in terrain more visible, Opportunity captured a striking false-color view of its own rover tracks. Taken at different wavelengths of light, such filtered images help scientists learn more about minerals found in Martian rocks and soil. The bluish hue is from iron-rich spherules nicknamed “blueberries,” which likely formed in the presence of water. The rover’s tracks are brighter and redder because the “blueberries” are pressed into the surface, exposing brighter, redder rust-colored dust.

Getting ready for a hike

Curiosity sent this scenic postcard of its ultimate science destination: the lower reaches of Mount Sharp in Gale Crater. Each rock layer in the mountain may contain evidence of the environmental conditions at a prior time in Martian history. The rover will ascend through them, reading the record of Martian history from older to younger. Scientists adjusted the color to show Mars under lighting conditions found on Earth, which helps in studying features in the terrain. The pointy mound (center) is about 1,000 feet (300 meters) across and 300 feet (100 meters) high.

A portion of the west rim of Endeavour crater sweeps southward in this enhanced color view from Opportunity. Not only is Endeavour crater 25 times wider than others Opportunity has explored, it offers access to older rock layers than any studied so far. These layers may hold clues to whether Mars provided habitable conditions for microbial life in earlier times. Opportunity has largely seen younger, sulfate-rich rocks that formed in acidic water. However, this west crater rim appears to contain deposits that formed by reacting with neutral water. Stein by the rover since the first days after landing, iron-rich spherules (“blueberries”) lie scattered over the land.
Though designed to take close-up, high-resolution views of rocks and soils, the camera at the end of Curiosity’s arm can also take snapshots of the surrounding terrain, or even the rover. Here, the arm reached out to peer beneath the rover’s body. Two images capture Curiosity’s three left wheels on the rocky Martian surface. The wheels will eventually carry the rover on its trek toward Mount Sharp, which rises in the distance above a thin line of dark sand dunes.

Getting a closer look

Opportunity closely inspected the mineral vein “Homestake,” which cuts a dashing line in the Martian terrain (top). About the width of a thumb and 18 inches (45 centimeters) long in this false-color view, the calcium- and sulfur-rich vein may be the mineral gypsum, which forms in the presence of water. In a close-up view about 5 centimeters across (bottom), subtle lines in the vein show where watery solutions once intruded into the rock and gypsum formed.

Curiosity used its laser to zap this rock, known as “Jake Matijevic.” To increase the visibility of differences within the rock, scientists white-balanced the background image (Mastcam). Superimposed on it are circular black-and-white images (ChemCam) taken to show pits made by the laser when it vaporized small areas in the rock (marked by red dots). To further analyze chemical elements in the rock, the mission team also targeted Curiosity’s Alpha Particle X-ray Spectrometer (purple circles).

Opportunity captured these sweeping vistas of Endeavour Crater during a long Martian winter. Pointing solar panels toward the Sun to gain power, Opportunity parked for four months of work on a northward outcrop called “Greeley Haven” (left). In an eastward view across Endeavour Crater, the rover caught its own late-afternoon shadow (right).

The dark areas in Endeavour Crater are deposits of dark sand. Comparisons of high-resolution orbital images show that the sand deposits move over time. Opportunity is also monitoring them for changes.

Credit: NASA/JPL-Caltech/Cornell/ASU.
To see a world in a grain of sand ...  
CURIOSITY

Curiosity’s wheel leaves a scuff mark in a wind-blown ripple of Martian sand. A number of larger grains originally on top of the ripple fell into the shallow trench made by the rover’s wheel. Eight images, each taken at a slightly different focus setting, combine to bring out details on the wall, slopes, and floor of the wheel scuff. The rover’s arm camera merged them onboard to reduce the amount of data sent to Earth.

Mars Hand Lens Imager, Sol 58 (October 4, 2012). Credit: NASA/JPL-Caltech/MSSS.
The large flat rock called “Whitewater Lake” shows signs of alteration. A rind (blue-colored in this false-color view) covers portions of its 30-inch (0.8-meter) surface. A rind is an exterior rock layer that shows signs of weathering. Opportunity has seen similar weathering rinds on rocks elsewhere within Meridiani Planum, where the rover has worked since landing in 2004.

Curiosity snaps its own self-portrait! Using its robotic arm camera, Curiosity took a set of images that scientists stitched together to create this "glamour shot" of the rover in its Martian home. Curiosity is by "Rocknest," the spot in Gale Crater where the rover collected its first scoop. Scoop scars lie in front of the rover. Behind Curiosity, Mount Sharp rises (top right), while the northern wall of Gale Crater looms hazily in the distance (top left).

**Portrait of a Martian**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>November</td>
<td></td>
</tr>
<tr>
<td>23 Nov</td>
<td>Curiosity launched 2011</td>
</tr>
<tr>
<td>30 Nov</td>
<td></td>
</tr>
<tr>
<td>December</td>
<td></td>
</tr>
<tr>
<td>01 Dec</td>
<td></td>
</tr>
</tbody>
</table>

**November 2014**

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

**December 2014**

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>
Mission Objective
To determine the climatic and geologic history of two sites on Mars with evidence of past, persistent water activity that may have supported microbial life.

Primary Mission
90 Martian days (sols)

Launch Vehicle
Boeing Delta II

Launch
Spirit – June 10, 2003 (UTC); Opportunity – July 7, 2003 (UTC)

Landing
Spirit – January 4, 2004 (UTC) at Gusev Crater (14.57°S, 175.47°E)
Opportunity – January 25, 2004 (UTC) at Eagle Crater, Meridiani Planum (1.95°S, 354.47°E)

Landing Technology
Atmospheric entry aeroshell, backshell with parachute and retrorockets, and airbags to cushion landing

Size
About the size of a golf cart — ~5 feet (1.5 meters) long, ~7 feet (2.2 meters) wide, ~5 feet (1.6 meters) tall

Arm Reach
~2.3 feet (0.7 meters)

Wheel Diameter
~10 inches (25 centimeters)

Mass
~400 pounds (180 kilograms)

Total Distance
Spirit – 4.8 miles (7.7 kilometers)
Opportunity – 22+ miles (35+ kilometers)

Images Sent to Earth
290,000+

Data Returned
50+ gigabytes

Quick Facts
Mars Exploration Rovers • Spirit & Opportunity

Mission Objective
To seek signs of past or present environmental conditions capable of supporting microbial life, including studies of rocks and minerals that formed in water and special clay minerals that can preserve organic, the chemical building blocks of life.

Primary Mission
One Mars year — about 23 Earth months

Launch Vehicle
United Launch Alliance Atlas V

Launch
November 26, 2011 (UTC)

Landing
August 6, 2012 UTC at Gale Crater (4.59°S, 137.44°E)

Landing Technology
Guided entry, powered descent, large parachute, and sky crane

Size
About the size of a car — ~10 feet (3 meters) long, ~9 feet (2.7 meters) wide, ~7 feet (2.2 meters) tall

Arm Reach
~7 feet (2.2 meters)

Wheel Diameter
~20 inches (50 centimeters)

Mass
~2,000 pounds (900 kilograms)

Images Sent to Earth
27,000+