Mission to Mars: Project Based Learning
Mars Geography
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http://www.edb.utexas.edu/missiontomars/bench/bench.html
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Like Earth, the surface of Mars has many kinds of landforms. Some of Mars’ spectacular features include Olympus Mons, the largest mountain in the Solar System. The Tharsis Bulge is a huge bulge on the Martian surface that is about 4000 km across and 10 km high. The Hellas Planitia is an impact crater in the southern hemisphere over 6 km deep and 2000 km in diameter. And the Valles Marineris, the dark gash in Mars’ surface shown in the picture below, is a system of canyons 4000 km long and from 2 to 7 km deep.

The white patches in the map of the Martian surface shown below are clouds and storms in Mars’ atmosphere.

Mars with clouds and storms, taken by the Hubble Space Telescope. NASA/JPL.

This is a map of Martian topography. In the left image, the Tharsis Bulge can be seen in red and white. The Valles Marineris is the long
blue gash through the middle. In the right image, the blue spot is the Hellas impact basin. Craters can also be seen in the right image.

This image is a flat map of Mars, made from data from an instrument aboard the Mars Global Surveyor. There are striking differences between the northern and southern hemispheres. The northern hemisphere (top) is relatively young lowlands. It is about 2 billion years old. The southern hemisphere (bottom) consists of ancient and heavily cratered highlands, much like the surface of the Moon. It is about 4 billion years old. There is a very clean boundary between the two regions, although the reason for this sharp break is unknown. It might be due to a very large impact that occurred just after the planet’s formation. The Hellas impact basin is visible as the bright blue region on the left side of the image. The Tharsis Bulge is the bright red region on the right side. It is interesting to note that these two features are located on exact opposite sides of the planet from each other. Olympus Mons is the white spot to the left of the Tharsis Bulge.

Mountains

The picture below shows the Libya Montes, examples of mountains on Mars. The Libya Montes were formed by a giant impact. The mountains and valleys were subsequently modified and eroded by other processes, including wind, impact cratering, and flow of liquid water to make the many small valleys that can be seen running northward in the scene. This picture covers nearly
Mountains on Mars. NASA/JPL.

**Volcanoes**

There is no known current active volcanism on Mars. All of the volcanoes on Mars appear to be extinct. Mars also lacks plate tectonics. Both volcanic and plate tectonic activity are caused by heat flowing from the interior of a planet toward the surface. Because Mars is much smaller than the Earth (about half its diameter), and is much less massive (about 1/10 the mass of Earth), the planet cooled off very quickly. There is no more heat to escape from the interior of the planet, and therefore all plate tectonic and volcanic activity has stopped.

The best known volcano on Mars is Olympus Mons, which is the largest volcano in the Solar System. It is a shield volcano, meaning that it has broad, gentle slopes that were formed from the eruption of lava. It rises 24 km (78,000 ft.) above the surrounding plains – much higher than Mt. Everest here on Earth. Its base is more than 700 km in diameter, which is bigger than the state of Missouri. It is rimmed by a cliff 6 km (20,000 ft) high. The last time Olympus Mons erupted was about one billion years ago.
Valleys

The following picture is an image of the Valles Marineris, the great canyon of Mars. It is like a giant version of the Grand Canyon. The image shows the entire canyon system, which is over 3,000 km long, stretching over about one-third of the planet. The canyon averages 8 km deep and might have formed from a combination of plate tectonics and erosion. Several craters are also visible around the canyon.

Craters

Like the Earth and the Moon, Mars also has impact craters. All three bodies have experienced approximately the same rate of cratering, but because of erosion, the craters have different appearances on each surface. Because the Moon has little to no atmosphere, most craters there look as fresh as the day they were made. Mars does support a thin atmosphere, so some erosion of craters there does take place. However,
the extent of this erosion is very small compared to the erosion of craters that happens on Earth.

Earth: This crater was created by a comet or asteroid that hit the Earth several hundred million years ago. It is located in the Sahara Desert in Chad, and it is about 17 km wide. Erosion of the crater is clearly visible.

Mars: This crater is located on the surface of Mars. While not as eroded as the craters on Earth, the rim of the crater has been sculpted by ice that forms on the ground.
Moon: These craters on the Moon are located near the Sea of Tranquility. Craters on the Moon show very little erosion because the Moon has very little atmosphere.

Surface rocks

In this image of the Martian surface taken by the Imager for Mars Pathfinder, the colors have been exaggerated to help show differences among the rocks and soils. It is clear from the image that there are three different types of rocks. The white arrows point to flat white rocks of unknown age. The red arrows point to large rounded rocks that show weathering on their surfaces, and so have probably been at the site for some time. The blue arrows point to smaller, angular rocks. These rocks have not been weathered, and so are thought to have been deposited or placed at this site recently, possibly by an asteroid impact.

The following images of rocks on the surface of Mars were taken by the cameras aboard the Mars Pathfinder.
Crust composition

Mars’ crust varies in thickness across the planet. In the northern hemisphere, the crust is only about 35 km thick, while in the southern hemisphere, it is about 80 km thick. This is probably caused by a period of uneven cooling that the planet experienced. For unknown reasons, Mars’ Northern Hemisphere cooled more slowly than the
Southern Hemisphere, causing it to form a smoother, thinner crust in that area. This image shows a possible configuration of soil and ice in the first three feet of the surface of Mars.

Soil composition on Mars. NASA/JPL.

**Atmosphere composition**

Mars’ atmosphere is composed mostly of carbon dioxide, which accounts for 96% of the total. The rest of the atmosphere is nitrogen, and argon, with very small amounts of oxygen. Mars has a very thin atmosphere; it is 200 times less massive than the atmosphere on Earth. It would not be possible for people to breathe on Mars – not only is the atmosphere very, very thin, there is not enough oxygen. However, it is thick enough to allow a parachute to slow an incoming spacecraft. Mars also has clouds and dust storms, as visible in the pictures below.

Clouds in the Martian atmosphere. NASA/JPL.

Clouds and Storms on Mars. NASA/JPL.

Ice caps
See also the benchmark lesson on Water on Mars.

Mars has ice caps at both its northern and southern poles. The ice is water ice and carbon dioxide ice (dry ice). In ideal observing conditions, it is possible to see the Martian ice caps from a backyard telescope on Earth.

In the summer, the ice caps shrink as the water ice evaporates, leaving behind the carbon dioxide ice.
The Benchmark Lessons were developed with the help of the following sources:


