Chapter 10
Mars
Units of Chapter 10

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Mars’s orbit is fairly eccentric, which affects the amount of sunlight reaching it.

When viewed from Earth, Mars can be located either in the general direction of the Sun (conjunction) or away from it (opposition).
10.2 Physical Properties

Radius: 3394 km
Moons: Deimos, Phobos
Mass: $6.4 \times 10^{23}$ kg
Density: 3900 kg/m$^3$
Length of day: 24.6 hours
10.3 Long-Distance Observations of Mars

From Earth, can see polar ice caps that grow and shrink with the seasons

Much better pictures from Mars missions, close-up
10.3 Long-Distance Observations of Mars

- Changing polar ice caps are frozen carbon dioxide; water ice is permanently frozen
- Shifting dust cover makes surface look like it is changing
- Frequent dust storms, with high winds
10.4 The Martian Surface

Major feature: Tharsis bulge, size of North America and 10 km above surroundings

Minimal cratering; youngest surface on Mars
10.4 The Martian Surface

This map shows the main surface features of Mars. There is no evidence for plate tectonics.
10.4 The Martian Surface

- Northern hemisphere (left) is rolling volcanic terrain
- Southern hemisphere (right) is heavily cratered highlands; average altitude 5 km above northern
- Assumption is that northern surface is younger than southern
- Means that northern hemisphere must have been lowered in elevation and then flooded with lava
Valles Marineris: Huge canyon, created by crustal forces

- 4000 km long
- Maximum 120 km wide, 7 km deep

Top right: Grand Canyon on same scale
10.4 The Martian Surface

Mars has largest volcano in solar system: Olympus Mons

- 700 km diameter at base
- 25 km high
- Caldera is 80 km in diameter

Three other Martian volcanoes are only slightly smaller
10.5 Water on Mars

Was there running water on Mars?

Runoff channels resemble those on Earth

Left: Mars
Right: Louisiana

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Open water (rivers, lakes) once existed on Mars; catastrophic flood occurred about 3 billion years ago
10.5 Water on Mars

This may be an ancient Martian river delta
10.5 Water on Mars

Much of northern hemisphere may have been ocean
10.5 Water on Mars

Impact craters less than 5 km across have mostly been eroded away.

Analysis of craters allows estimation of age of surface.

Crater on right was made when surface was liquid.
Recently, gullies have been seen that seem to indicate the presence of liquid water; interpretation is still in doubt.
More intriguing, this pair of images appears to show that gully formation is ongoing.
Some water may now be permafrost under polar ice caps
Left: Southern polar cap, mostly carbon dioxide
Right: Northern polar cap, mostly water
Both images taken during local summer
10.5 Water on Mars

*Viking* landers both landed in low-latitude northern plains

Rocky surface, red due to iron content

*Viking 1*
10.5 Water on Mars

Viking 2
10.5 Water on Mars

The landing site for *Opportunity* was chosen to maximize the chances of finding water, or evidence for water.
10.5 Water on Mars

The *Curiosity* rover landed on Mars in 2012, and is also looking for evidence of water on Mars, by searching for carbonate rocks.
**Discovery 10-1: Life on Mars?**

*Viking* landers looked for evidence of living organisms; did not find anything conclusive.
Discovery 10-1: Life on Mars?

Two Martian meteorites found in Antarctica show possible signs of microbial life, but evidence is disputed.
Martian atmosphere is mostly carbon dioxide, and very thin
Too thin to retain much heat; temperature drops sharply at night
Fog can form in low-lying areas, as sunlight strikes
Mars may be victim of runaway greenhouse effect in the opposite sense of Venus’s.

As water ice froze, Mars became more and more reflective and its atmosphere thinner and thinner, freezing more and more water and eventually carbon dioxide as well.
10.6 The Martian Atmosphere

As a result, Mars may have had a thicker atmosphere and liquid water in the past, but they are now gone.

(a) Ancient Mars
(b) Today's Mars
10.7 Martian Internal Structure

- No seismic studies have been done

- From behavior of crust, it is estimated to be 100 km thick

- No magnetic field, so core is probably not metallic, not liquid, or neither liquid nor metallic
10.8 The Moons of Mars

Mars has two tiny moons:

Phobos (left, 28 km x 20 km); Deimos (right, 16 km x 10 km)

Deimos probably captured from the asteroid belt; Phobos may have formed later, from material ejected from Mars by a meteor strike.
Summary of Chapter 10

- Mars’s orbit is more eccentric than Earth’s
- Rotates in 24.6 hours; axial tilt similar to Earth’s
- Atmosphere very thin, mostly carbon dioxide
- Temperature averages 50 K below Earth’s, but seasons are otherwise similar
- Mars landers have yielded substantial amounts of data
Summary of Chapter 10 (cont.)

- Northern and southern hemispheres are very different
- South is higher and heavily cratered
- North is lower and relatively flat
- Major features: Tharsis bulge, Olympus Mons, Valles Marineris
- Crater ejecta provide evidence for permafrost layer under surface (easily liquidized)
- Two small moons