8th Ed. Astronomy Today.
Mars
Ch. 10 R&D answers (only 1-15 odd were assigned)

REVIEW AND DISCUSSION

1. During opposition, Mars and Earth are lined up on the same side of the Sun. In this configuration, they are at their closest to each other. Consequently, Mars is at its brightest, and has its largest angular size as seen from Earth at this time. Also, Mars rises at sunset and sets at sunrise, so it is available for viewing all night. If both planets had perfectly circular orbits, all oppositions would be the same. But both planets have non-circular orbits, Mars especially so. Therefore, the most favorable oppositions occur when Mars in at its closest point to the Sun (perihelion) and Earth is at its farthest point from the Sun (aphelion). Oppositions occurring at other times will not be as close.

2. Mars is near perihelion during southern summer, so there is increased solar heating du ring that time. With more energy in the atmosphere, convection is very fierce, and strong winds blow the Martian dust around. At some times during southern summer, airborne dust can cover the entire planet.

3. The two polar ice caps of Mars have very different characteristics. In their respectiv e winters, the two seasonal ice caps are made up almost entirely of frozen carbon dioxide . Since Mars's very eccentric orbit means the southern winter is longer and colder than t he northern winter, the southern seasonal cap is larger (4000 km in diameter) than the no rthern seasonal cap (3000 km). In southern summer, the southern cap almost entirely vanis hes, down to a residual cap of 350 km in diameter. The northern residual cap is larger, 1 000 km across, due to the milder northern summer and a higher abundance of water ice. The northern cap actually gets a little warmer than the southern cap, probably due to a high abundance of sunlight-absorbing dust infused during the dust storms of southern summer.

4. The Martian soil is full of oxidized materials, the most prominent of which is iron ox ide, or rust. The rust in the Martian soil gives it the distinctive color.

5. The polar ice caps of Mars, made primarily of frozen water and carbon dioxide, are vis ible from Earth. The Tharsis Bulge is a large upraised area on Mars, and the closest thin g to a "continent" Mars has. Large volcanoes are found in the Tharsis area, including Oly mpus Mons, the largest volcano in the Solar System. The Valles Marineris is a great crack that dominates the equatorial region of Mars, likely caused by the same internal forces that raised up the Tharsis Bulge. The Hellas Basin is an immense impact feature almost di ametrically opposed to the Tharsis Bulge on the surface of Mars.

6. Two factors led to the immense sizes of the Martian volcanoes. First, Mars has a lower gravity than Earth or Venus, so mountains can rise higher on Mars before gravity keeps t hem from getting higher. Second, there is little evidence that Mars ever had plate tecton ics. On Earth, the movement of the Earth's crust prevents material from piling up too muc h in one place, and volcanic mountains cannot get too high.

7. First, the Martian atmosphere is very thin, with less than a percent of the Earth's at mospheric pressure. Second, the Martian atmosphere is made almost entirely of carbon diox ide, with little to no oxygen.

8. We see many signs of water erosion on Mars, including river channels, flood plains, an d gullies running down the sides of craters. Recent analysis of surface rocks by rovers h ave also revealed chemical compounds that typically form in water-rich environments. Howe ver, it is highly unlikely that liquid water can exist today on the surface of Mars, due to the cold temperatures and low atmospheric pressure. Liquid water may exist temporarily

, but either freezes or evaporates quickly. Mars must have had a thicker atmosphere and a higher temperature in the past.

9. Water exists on Mars, in the form of water vapor in the atmosphere, and as ice at the polar caps and possibly under the surface.

10. There are structures in the Martian northern hemisphere resembling outflow channels a nd river deltas. Much of the northern hemisphere is low in altitude and sparsely cratered , looking much like the ocean floor. Therefore, some astronomers think that Mars had an e xtensive ocean of liquid water around its north pole in its past.

11. All three planets started out with atmospheres made primarily of carbon dioxide. Beca use Earth was at the right distance from the Sun to have large amounts of liquid water, a large portion of its carbon dioxide was dissolved into the oceans and incorporated into carbonate rocks. Primitive plants also converted large amounts of carbon dioxide into oxy gen. Venus was too close to the Sun to have large amounts of liquid water or plant life, and so it could not thin out or otherwise transform its atmosphere from this initial stat e. Mars may have been close enough to the Sun to have oceans, so it may have placed a gre at deal of its atmospheric carbon dioxide into surface rocks, thinning out its atmosphere . It is also possible that an impact with a huge meteor further thinned the atmosphere. W ith a thinner atmosphere, liquid water could not exist on the surface. What oxygen there may have been in Mars's atmosphere has mostly combined with surface rocks to create oxyge n compounds, especially rust.

12. Mars has a very weak magnetic field that may not be present around the entire planet. This decaying field indicates that Mars is no longer actively generating a magnetic fiel d. Since Mars is rotating as rapidly as the Earth is, this indicates that Mars has an onl y partially metallic core that has solidified.

13. Earth is a highly differentiated planet, with mostly low-density rock on the surface and mostly high-density metal in the center. The Earth is differentiated because it was i n a liquid state for a long time (parts still are) and high-density materials sunk to the center, pushing low-density materials upward. This process was not able to progress as f ar on Mars. The rust on the surface indicates a large amount of iron that did not sink to the center, and the barely-present magnetic field indicates a core that is not pure meta l. The process of differentiation was interrupted when Mars solidified early in its histo ry.

14. The Martian atmosphere is very thin, with a pressure about 1/150 of Earth's. There ma y be a great deal of carbon dioxide as a percentage, but in terms of number of carbon dio xide molecules, there are very few in Mars's atmosphere to retain heat. In fact, as Mars got colder and colder, more and more water vapor and carbon dioxide froze out of the atmo sphere, actually reversing the greenhouse effect.

15. We were able to measure the masses of Phobos and Deimos by measuring their gravitatio nal effect on the path of the Viking orbiters as they flew by the moons of Mars. Once we knew the mass, we could calculate the densities of the moons. Those low densities, combin ed with the low masses and irregular shapes of the two satellites, have led us to the con clusion that they are asteroids that wandered too close to Mars and were captured by its gravity.