Chapter 10 Review and Discussion Questions - Answers.

(Only even numbered questions were assigned.)

ANSWERS TO CHAPTER 10 REVIEW QUESTIONS

1. Mars is best viewed from Earth at opposition, when it is directly opposite the Sun. At this time, Earth and Mars are at their closest.

2. Mars's orbit is fairly elliptical, with an eccentricity of 0.09. But because of its orbital eccentricity the view at opposition may or may not be favorable. The ideal situation is when Mars is at perihelion when it is also at opposition. It is then the closest to Earth as it can ever get.

3. The canals were just figments of the imagination of those who believed they had to exist. Percival Lowell mistakenly believed canals had been discovered by Italian astronomers and jumped to the conclusion that there was life on Mars. He built and funded the operation of an entire observatory dedicated to their study and further discovery. Any canal that might have existed was known by astronomers to be impossible to see from Earth; it would have to be enormous is size and contrary to the fact that there was little evidence of water on Mars. All this has had a happy ending, though. The Lowell Observatory in Flagstaff, Arizona became an important research facility for astronomy and has been productive for many years.

4. Temperatures would sometimes rise above freezing, but dust storms are common. Strong winds at the surface sweep up the dry dust, carry it aloft, and eventually deposit it elsewhere on the planet. Such storms are far worse than any dust storm on Earth.

5. The two polar caps are actually composed of two separate caps each, the seasonal cap and the residual cap. The seasonal cap has a composition of frozen carbon dioxide. they grow during the winter and diminish during the summer. The southern residual cap has a composition of frozen carbon dioxide, with some frozen water. The northern residual cap is almost 3 times larger than the southern residual cap and is composed mostly of frozen water.

6. The soil of Mars has a large amount of iron oxide in it, i.e., rust. This gives Mars its red or rust color.

7. The northern hemisphere is mostly volcanic plains with some large volcanoes. It is relatively young in age. The southern hemisphere is heavily cratered highlands lying several kilometers above the level of the lowland north. The Tharsis bulge is on the equator and lies about 10 km above the surface. It is the youngest part of the surface. Both hemispheres have seasonal and permanent ice caps.

8. Gravity on Mars is only 40 percent of what it is on Earth. The height to which a shield volcano grows depends on its ability to support it own weight. With lower gravity, the volcanoes grow correspondingly higher.

9. There's not much to breathe on Mars! Its atmosphere is less than a hundredth that of the Earth's atmosphere. Even if you could breathe such a thin atmosphere it wouldn't do you much good; it is composed mostly of carbon dioxide. Note, though, that this is not necessarily true for some simple plants, which absorb carbon dioxide (as all plants do) and might be able to survive in this thin atmosphere.

10. River and stream channels are certain evidence that water once flowed on the surface of Mars. The same might be said for similar features in some of Earth's most arid deserts, where water may flow for only a matter of hours during an entire year. But the water flow on Mars is not seasonal as it is on Earth.

11. There is no liquid water on Mars today because water can only exist as a solid or gas. The atmospheric pressure is too low for liquid water.

12. Liquid water cannot exist on Mars today because the atmospheric pressure is too low; the water would immediately boil into a gas and would be evident in the atmosphere of Mars. But this is not observed; Mars has little water in its atmosphere. Frozen water does exist in the polar ice caps and, potentially, there still may be large amounts of water present in the crust of Mars, below the surface.

13. The north polar region and the Hellas basin are both possible sites of ancient oceans.

14. The *Viking* orbiters measured the gravitational effects of both moons and estimated their masses. Their densities are about 2 g/cm^3, which is rather low for rocky bodies and suggest that they were captured by Mars and did not form along with Mars.

15. Mars does not have a magnetic field generated like Earth's. This suggests that its interior is not molten or is not made up of an extensive iron core like the Earth.

16. Mars has no current volcanic activity. It lacks a significant magnetic field. It has a relatively low density and high abundance of iron on its surface. All these facts suggest that Mars never melted as extensively as did Earth.

17. Earth, at its closest approach to Mars, would appear about twice the size that Mars does from Earth. Earth would be seen as an inner planet from Mars and would appear to go through phases. At closest approach (Mars in opposition and perihelion) Earth would look quite dark because its night side would be facing Mars. At better angles, Earth would have a variety of colors; blue, browns, and whites of the oceans, continents, and clouds and ice regions. Earth would not be the "red planet" like Mars is to us but possibly the "blue planet" from Mars.

18. Water might be obtained from the ice caps of Mars or from subsurface deposits. Air to breathe would be more difficult to come by. Oxygen could be extracted from the oxides in the surface soils but nitrogen would be rare and have to be imported. Carbon dioxide for growing plants could be collected and concentrated from the atmosphere. Energy would have to come from sunlight but Mars receives less than half the sunlight Earth receives, per square meter. There are many other environmental factors that could be discussed here.

19. There is plenty of carbon dioxide to create a greenhouse effect, just no significant atmosphere to be warmed by it. The atmosphere of Mars is less than one percent that of the Earth and produces little insulation to keep the surface warm.

20. All three planets had their secondary atmospheres produced by outgassing of their volcanoes. Abundant quantities of water and carbon dioxide were likely produced in all three cases. Now, however, the evolution of these atmospheres depend on the planet's distance from the Sun. Really, it is just the story of the three bears; one that was too hot, one that was too cold, and one that was just right. Venus, at the closest distance, was warmer and very likely never had liquid water on its surface. Both water and carbon dioxide are efficient greenhouse gases, so Venus warmed up quickly to a high temperature. Its atmospheric water was subsequently destroyed by solar ultraviolet light.

Planck curve spectrum characteristic of a temperature near 600 K. It was hardly a tropical, habitable planet.

8. The ultraviolet images revealed fast moving upper layers of clouds. These clouds had velocities of up to 400 km/hr.

9. The atmosphere of Venus has a total mass about 90 times greater than that of Earth. It extends to a much greater altitude--90 percent of the Earth's atmosphere lies within about 10 km of the surface, compared with 50 km on Venus. The surface temperature and pressure of Venus's atmosphere are much greater than Earth's.

10. The dominant component of the atmosphere of Venus is carbon dioxide. It accounts for 96.5 percent of the atmosphere by volume. Almost all of the remaining 3.5 percent is nitrogen. Trace amounts of other gases, such as water vapor, carbon monoxide, sulfur dioxide, and argon are also found. The clouds are made of sulfuric acid.

11. Venus has both a very thick atmosphere and one mostly composed of carbon dioxide. Carbon dioxide is a very effective greenhouse gas, trapping infrared light within the atmosphere and raising the temperature. This, in combination with the largeness of the atmosphere, has produced a very large greenhouse effect and a resulting high temperature.

    On Earth, almost all of the water vapor and carbon dioxide present in the planet's early atmosphere quickly became part of the surface of the planet, in the oceans or in the surface rocks. On Venus, the temperature may have been so high that no oceans condensed, in which case water vapor and carbon dioxide remained in the atmosphere. The carbon dioxide was never incorporated in the crust of Venus. The water was slowly broken down by solar ultraviolet light in to hydrogen and oxygen. The hydrogen escaped into space and the oxygen formed oxides of sulfur and carbon.

12. When Venus was young, even with some liquid water, its higher temperature, due to its closeness to the Sun, increased atmospheric water and raised its temperature. This did not allow carbon dioxide to remain dissolved in the oceans, forcing it out into the atmosphere and further increasing the greenhouse effect and the temperature.

13. Its climate might be similar to Earth's. An important point to remember, however, is that Venus is a smaller planet with a lower surface gravity. It might not have been able to hold onto as much of an atmosphere as the Earth.

14. The continents of Venus make up only 8% of its surface, as compared to the 25% of the Earth's surface. They are not tectonically produced but do show extensive lava flows. The mountains are of similar height but are produced by upward convective flows and not the tectonic activity found on Earth.

15. There is a strong deficiency in small impact craters on Venus, due to its atmosphere destroying meteoroids smaller than about 1 km. The smaller impact craters show evidence of the meteoroid being shattered prior to impact. There is also a deficiency in larger craters, but this is likely due to the surface of Venus being resurfaced by volcanic activity.

16. Volcanic craters are very common on the surface of Venus. The largest features are the coronae, formed from upwelling mantle material. The deficiency in large impact craters suggests significant resurfacing by lava flows.

17. The level of sulfur dioxide above Venus's clouds show large and fairly frequent fluctuations which may be the result of volcanic eruptions. The *Pioneer* and the *Venera* orbiter observed

bursts of radio energy from the Beta and Aphrodite regions, similar to those produced by lightning discharges that often occur in the plumes of erupting volcanoes on Earth.

18. The dynamo model for the production of planetary magnetic fields requires both an iron-rich core and a relatively rapid rate of rotation. Venus lacks the rapid rotation and therefore does not appear to produce a magnetic field. Actually, the fact that it does not have a magnetic field strongly suggests that the dynamo model is correct.

19. Life on Venus appears to be impossible due to its very high temperature. This temperature is sufficient to break down virtually any important molecules that would be necessary for life. In addition, the environment of sulfuric acid would be very destructive to these same molecules. The absence of water does not help either!

20. Earth's greater distance from the Sun and its large amount of liquid water on its surface are both factors that would help prevent a runaway greenhouse effect like that of Venus. Most of our carbon dioxide is locked away in the crustal rocks. It would all have to be released in order for Earth to become like Venus. This could only happen if Earth's temperature increases dramatically. But there are no mechanisms to heat the Earth to get this started Venus started with higher temperatures because of its closeness to the Sun.