

## Chapter 9 Review and Discussion Questions - Answers.

(Only even numbered questions were assigned.)

### ANSWERS TO CHAPTER 9 REVIEW QUESTIONS

1. Venus is the third brightest object in the sky, after the Sun and Moon. It is completely covered by very reflective clouds so that much of the sunlight received by Venus is reflected back into space. Venus also is one of the closest planets to the Earth, depending on where it is in its orbit. This also helps make Venus appear bright. Its brightness depends on its phase and distance from the Earth.
2. Since Venus is an inner planet, it will never be found too far from the Sun. However, it is much easier to see than Mercury, having an orbit almost twice the size of Mercury's.
3. The "near-resonance" is not an exact one, as would be expected if it is real. The Earth does not exert a strong enough gravitational pull on Venus to be able to pull into this resonance.
4. The problem with the "near-resonance" is that the same side of Venus points towards Earth each time they are at closest approach. So one side gets mapped better than the other. Of course the best mapping has been done in orbit around Venus, so this is no longer a significant problem.
5. It is possible that Venus was struck by a large object in just the right way to almost stop it from rotating.
6. Technically, you could not see Earth from the surface of Venus because of all the cloud cover of Venus. If you could see Earth, it would appear slightly larger than does Venus from Earth, a bit darker because of its lower albedo, and there would certainly be visible the blue, browns, and whites of the oceans, continents, and clouds and ice regions. Earth would not go through phases like Venus because it would be seen as an outer planet.
7. At one time, Venus was thought to have a warm, tropical environment. In the 1950s, radio observations of Venus measured its thermal emission. The radiation emitted by Venus has a

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 into 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.