1. Earth's atmosphere differs from those of near-neighbor planets, Venus and Mars, in one important respect in that (d) it has a significant fraction of oxygen in it.

2. The albedo of a planet is the fraction of energy that is (b) reflected by the whole planet, including atmosphere and surface.

3. The greenhouse effect is the (d) absorption by atmospheric gases of infrared radiation emitted by a planet that has been heated by solar visible and ultraviolet radiation.

4. “Chemical differentiation” in planetary sciences refers to (d) the sinking of heavier elements toward the center of a planet and the floating of lighter elements toward the surface.

5. What is the basic structure of Earth's interior? (a) solid iron inner core, molten iron outer core, rocky mantle, lighter rocky crust

6. The Shadow Zone, in which seismic waves from an earthquake can be detected only very faintly, is caused by (b) S and P waves being refracted at the boundary of Earth's core and S waves being absorbed by the core.

7. Within Earth the temperature (c) at some locations is greater than the condensation temperature of the materials at that location and at other locations it is less.

8. Earth's magnetic field is caused by (a) electric currents flowing in the molten core.

9. Aurorae on Earth are caused by (b) charged particles from the sun moving through Earth's magnetic field and striking the upper atmosphere.

10. The large amount of free oxygen in Earth's present atmosphere is primarily a result of (b) a biological process such as photosynthesis.

11. Earth's stratosphere is warmer than the layers above and below it because (d) ozone in the stratosphere absorbs ultraviolet radiation from the Sun.
12. Which of the following statements correctly describes the surface of Earth?
(c) individual and separate solid crustal plates floating on, and being pushed around by, the underlying semimolten mantle

13. Billions of years ago, Earth's atmosphere was composed primarily of carbon dioxide. What happened to much of this carbon dioxide?
(c) It dissolved into Earth's oceans and got locked up in carbonate rocks.

14. What is the basic structure of Earth's atmosphere?
(d) four layers of alternating temperature profiles: temperature decreasing, then increasing, then decreasing, then increasing with altitude

15. Which of the following general statements about the Moon is true?
(a) There is one side of the Moon from which Earth can never be seen.

16. Libration is
(a) apparent wobbling of the Moon due to the shape and orientation of its orbit and rotation axis.

17. What actually moves around the Sun along the path we usually call Earth's orbit?
(c) the center of mass of Earth-Moon system

18. The lunar maria appear smooth because they are
(d) ancient lava flows that occurred soon after the end of an early period of intense bombardment and have had relatively few impacts since then.

19. Which of the following processes has played the greatest role in shaping the surface of the Moon?
(b) impacts of interplanetary bodies of all sizes

20. How were the mountain ranges on the Moon formed?
(b) They were rims of ancient craters, thrust up by impacts of large asteroids.

21. How many human beings have walked on the Moon?
(d) 12

22. The age of the moon is determined by
(a) measurements of radioactive elements and radioactive dating.

23. Which of the following statements is a correct description of the Moon's orbit?
(c) The Moon is gradually spiraling away from Earth.

24. Compared to earthquakes, moonquakes are
(c) much weaker and less frequent, occurring mostly when the Moon is at perigee.
25. One theory about the origin of the Moon states it was formed from debris thrown out when a Mars-sized object collided with Earth. One fact that strongly supports this theory is that (d) Moon rocks are very similar to those of Earth but are depleted in elements that melt at relatively low temperatures.

26. When Venus is at its brightest as seen from Earth (near greatest elongation), it is (a) the brightest celestial object in the sky other than the Sun and Moon.

27. Mars is best viewed from Earth when it is at opposition, but some occasions are more favorable than others. Why is this? (a) Mars has an elliptical orbit, and favorable oppositions occur when Mars is at perihelion in its orbit and hence closest to Earth.

28. In view of Mars's tilted angle of rotation at 25° to the ecliptic, its very similar rotation period to that of Earth (24 hours, 37 minutes), and its orbital period of nearly 2 years, what will be the seasonal variations on Mars, compared to those upon Earth? (c) very similar seasonal variations, but with each season lasting twice as long as Earth's seasons

29. Mercury is much closer than Venus to the Sun, and yet it never appears brighter than Venus, even when both are at maximum brightness, because (d) Mercury is small, has a dark surface, and has no reflecting clouds.

30. If you are on Mercury and the time is noon (Sun directly overhead), what time of day will it be one Mercurian year later (after Mercury has orbited the Sun once)? (d) midnight

31. The surface of Mercury, unlike the highland regions of the Moon, has extensive plains between the craters. The reason for this is thought to be that (b) Mercury is larger than the Moon, and it cooled more slowly, leaving lava to flow more recently across its surface than it has over the lunar highlands.

32. Why has the greenhouse effect been much more effective in raising the surface temperature on Venus than on Earth? (c) CO₂, which traps heat from the planet's surface, is the major component in the very dense Venusian atmosphere but only a minor constituent of Earth's atmosphere.

33. The internal structure of Mercury is a (c) dense iron core taking up almost half of the volume of the planet and a rocky mantle surrounding the core.

34. The rotation rate of the planet Venus was first determined by measuring (c) the Doppler shift in radio waves reflected from the planet's surface.
35. To measure the surface temperature of Venus, *Mariner* 2 measured emissions with wavelengths of 1.35 cm and 1.9 cm. The temperature of Venus is 730 K. What is the peak wavelength in the emission spectrum of Venus?
(c) 4 µm

36. What observations of the Martian surface led Percival Lowell to the conclusion that intelligent life forms existed upon Mars?
(b) melting icecaps, a network of linear features that look like canals, and varying dark surface markings, assumed to be vegetation

37. Venus has
(a) no magnetic field.

38. The most common surface features on Venus are
(c) volcanoes and lava flows.

39. The overall geography of Mars can be best summarized as
(a) major volcanoes in the northern hemisphere, extensively cratered plains in the southern hemisphere, the hemispheres separated by one major valley system.

40. Hot-spot volcanism is a process that
(a) produces gigantic volcanoes on Venus and Mars but produces chains of smaller volcanoes on Earth (e.g., the Hawaiian Islands).

41. The best images of the overall topology of Venus have been produced by
(d) reflection of microwave and short radio wave radiation from the surface by an orbiting spacecraft.

42. The major volcanoes on Mars have formed
(b) directly above stationary hot-spots in the mantle.

43. The relative rotation patterns of the Venusian atmosphere and Venus itself are
(c) slow (243 days) retrograde rotation of planet and rapid (4 days) retrograde rotation of upper atmospheric clouds.

44. Why did the *Venera* series of spacecraft survive for only a few minutes on Venus's surface?
(b) Conditions of extreme pressure, corrosive atmosphere, and high temperatures caused severe damage.

45. The circulation pattern in Venus's atmosphere consists of
(a) one main convection cell in each of the northern and southern hemispheres, which extends from the equator almost to the poles and drives weaker cells above and below it.
46. On the basis of the surface and atmospheric conditions existing on Mars today, why could there be no permanent liquid water on its surface?
(a) The water would boil and evaporate rapidly under the low atmospheric pressure or freeze to ice at the low surface temperatures.

47. The initial and very rapid recession of the edge of the white polar cap region toward the poles in springtime is caused by
(a) the melting and evaporation of CO₂ ice.

48. A major feature of the atmosphere of Mars is
(a) occasional strong winds and dust storms.

49. The pressure of the atmosphere of Mars—primarily carbon dioxide (CO₂)—compared to the atmospheric pressure at Earth's surface, is
(b) less than 1/100.

50. How did the inner planets, Venus and Earth, acquire their original atmospheres?
(d) outgassing of the planets through volcanoes and other vents

51. The Viking Lander spacecraft measured a steadily decreasing atmospheric pressure soon after landing on Mars. What was found to be the cause of this observation?
(d) Atmospheric CO₂ was freezing out into “dry ice” as colder temperatures signaled the onset of the Martian winter.

52. The greenhouse effect, which heats a planet's surface above the predicted equilibrium surface temperature for the planet without an atmosphere, is far less effective on Mars than on Earth. Why is this?
(d) The Martian atmosphere is very thin and traps less infrared radiation from the surface.

53. The original Mars landings were made by the Vikings in 1976 and 1977. Three more landings have been made since: Mars Pathfinder and the exploration rovers Spirit and Opportunity. What is the main advantage of these last three over the older Vikings?
(c) The Vikings had to remain where they landed but the more recent craft have been able to explore far and wide across the surface.

54. Which of the following has apparently had the least influence on the evolution of the surface and geology of Mars?
(b) an internal magnetic field

55. What significant evidence exists for the idea that large quantities of water once flowed on the planet Mars?
(d) deep, winding canyons and flood plains

56. The carbon dioxide atmosphere of Mars was much denser in Mars's early history than it is now. What process is believed to have begun this atmospheric thinning?
(d) The CO₂ was washed out of the atmosphere by rain.
57. Phobos, the innermost moon of Mars, has an orbital period that is less than one Martian day. This means that, as seen from Mars, Phobos appears to (b) rise in the west, traveling eastward.

58. At what point in its orbit does Jupiter appear to be brightest when viewed from Earth? (a) opposition

59. The lifetime of the Great Red Spot appears to be (c) at least 300 years, from visual records.

60. Saturn’s sidereal period around the Sun is approximately 29 years. The time interval between viewing Saturn at opposition and next viewing it again at opposition is (c) slightly more than one year.

61. How does the composition of Saturn's atmosphere compare to that of Jupiter, which is the same as that of the Sun? (a) Saturn's atmosphere contains less helium than does that of either Jupiter or the Sun.

62. The rotation periods of Jupiter and Saturn are (b) relatively short—on the order of 10 hours.

63. Each of the following provides evidence for the large amount of hydrogen in the atmosphere of Jupiter except one. Which is the exception? (a) differential rotation

64. The circulation pattern in and around the Great Red Spot on Jupiter is (d) counterclockwise between two sets of winds flowing in opposite directions.

65. When viewed in the infrared light emitted by the clouds, the brightest parts of Jupiter are (a) in the belts, which correspond to deeper and hotter regions.

66. The source of excess heat emitted by Jupiter, above that which is absorbed as sunlight and reemitted, is thought to be (c) gravitational potential energy released as heat during its formation stages, still being released.

67. The material in the interiors of Jupiter and Saturn thought to be responsible for their powerful magnetic fields is (b) liquid metallic hydrogen.

68. Other than the rings, how does the appearance of Saturn differ from that of Jupiter? (a) There are belts and zones on Saturn, but they are very faint and hazy compared to Jupiter's.
69. The overall interior structure of Jupiter and Saturn is expected to be
(c) four-layered—a rocky inner core, a liquid outer core of “ices,” a mantle of liquid
hydrogen and helium, and an extensive gaseous atmosphere.

70. Saturn appears to emit heat as infrared radiation in excess of the energy absorbed
from sunlight. The most likely major cause of this heating is
(a) condensation of helium into droplets that fall into the planet, generating heat via
friction with the surrounding gases.

71. The rings of Saturn are seen by
(c) reflected and scattered sunlight.

72. The Roche limit around a planet is defined as
(d) the distance inside which relative tidal forces will overcome the mutual gravitational
forces of a group of particles.

73. Why do the rings of Saturn alternately appear very distinct and then almost disappear
when viewed from Earth over periods of a few years?
(d) The plane of the rings is tilted with respect to the ecliptic plane and thus appear edge-on at times.

74. The relationship between the Saturnian moon Mimas and the Cassini division in the
rings of Saturn is that
(d) Mimas’s orbital period is a factor of 2 greater than that of particles inside the Cassini
division, thereby perturbing their orbits.

75. Why is Saturn’s F ring much narrower than its main rings?
(c) Two “shepherd” satellites focus the particles into a narrow ring.