SESSION TEN: THE INNER PLANETS

MERCURY

A. Physical and orbital parameters
   1. Diameter is 3030 miles (4877 km) making Mercury the smallest planet in the solar system.
   2. Orbital period is 88 days. Orbital eccentricity is 0.206
      a. Perihelion: 29×10^6 miles or 46.7×10^6 km
      b. Average: 36×10^6 miles or 57.9×10^6 km
      c. Aphelion: 43×10^6 miles or 69.2×10^6 km
   3. Mercury's rotation: Early observers of Mercury thought that its rotation and revolution were synchronous, occurring in 88 days. Doppler shift measurement made by the Arecibo radio telescope in Puerto Rico showed that Mercury was rotating in a period that was 2/3 of its orbital period or 58.65 days.
   4. Spin orbit coupling: Mercury's rotation/revolution are in a 3:2 resonance which allows the Messenger God to make exactly three rotations in two revolutions.
   5. Mercury's axis is perpendicular to its orbital plane so seasons on Mercury are not a function of axial tilt.
   6. Climate varies with both latitude and longitude: Because of Mercury's spin orbit coupling with the sun, the same circles of longitude (0 degree and 180 degrees) are successively exposed to the sun perihelion occurs at the conclusion of each revolution. These locations receive of 2.5 times the noontime energy that longitudes of 90 degrees and 270 degrees receive when the planet is at aphelion and facing the sun at noon. Here temperatures range from -279 at sunrise and 800 degrees F. during the noontime. Subsurface equatorial temperatures are always above freezing while polar subsurface temperatures are always below freezing. Permanently shadowed regions in craters at the poles contain water ice
   7. The sun's daily motion at its hotspots: Because of Mercury's orbital eccentricity and its slow angular rate of rotation, the daily westward motion of the sun due to rotation is completely eliminated by its rapid eastward orbital velocity at perihelion. This causes the sun to retrograde toward the east and create a small eastward loop about seven degrees across near perihelion.
   8. Length of a day on Mercury: From sunrise to the next sunrise takes 176 days with the sun visible above the horizon for 88 days.
   9. Atmosphere: There is virtually no atmosphere on Mercury except for a slight concentration of hydrogen and helium in the vicinity of the planet. Its proximity to the sun and weak gravitational attraction make it impossible for Mercury to retain a permanent atmosphere.
   10. Density and internal structure:
      a. Average density: 5.4 gm/cm^3
      b. Internal structure: Mercury has a thin crust, perhaps 30 miles (50 km) deep, a relatively thin mantle, 400 miles (640 km) in thickness, and a massive iron core, 1100 miles in radius (1800 km) in radius.
      c. Core to planet ratio is the largest of any planet in the solar system. The most refractory material condensed nearest to the sun as the solar nebula first cooled, allowing Mercury to accrete mainly from these substances.

d. Mercury's surface contains the highest ratios of volatiles, potassium and sulfur of any of the terrestrial planets, including the moon, creating an enigma with its location to the sun.

B. Surface of Mercury
   1. Mercury's surface was thought to be cratered before the first remote flyby in 1973 because its phase-brightness relationship nearly identical to the moon's, so astronomers were reasonably confident that Mercury's surface was cratered.
   2. Crater densities are comparable to the moon and Mars, but not in the Caloris Basin region of Mercury. Mercury's crater diameters rarely exceed 37 miles (60 km) and there are more intercrater plains, flat regions between craters.
      a. The outer planets may have propelled cometary objects high above the plane of the solar system to impact on the inner four planets. This would explain similar crater densities found on the inner planets.
      b. Other impacts may have originated from the asteroid belt.
   3. Secondary craters

CAN YOU ANSWER THE FOLLOWING QUESTIONS/STATEMENTS ABOUT THE INNER PLANETS, MERCURY, VENUS, AND MARS?

MERCURY

1. The average distance of Mercury from the sun is only _____ miles making it a difficult planet to observe. A year on Mercury transpires in only _____ Earth days.

2. Prove to yourself that Mercury, just like the moon, goes through a complete series of phases as we observe it from Earth.
   a. When Mercury is between the Earth and the sun, its phase would be the same as when the moon is _____.
   b. When Mercury is on the opposite side of the sun, its phase is _____.
   c. When the sun-Mercury-Earth angle is equal to 90 degrees, the phase of Mercury is _____.

   Just like the moon, the amount of time that it takes Mercury, or any other planet, to repeat a cycle of phases is equal to the **synodic** period of that object.

3. The manner in which Mercury's brightness changes with its phase is in correlation with the moon's phase-brightness relationship. Astronomers assumed, even before the space-age, that there were similarities in the appearance between both bodies and thought that Mercury possessed a significant number of _____.

4. The spacecraft which proved that Mercury did indeed look similar to the moon was called _____ (1974). Currently _____ (acronym), MEcury Surface, Space ENvironment, GEochemistry, and Ranging satellite is in orbit around Mercury.

5. On the Earth, climatic variations are basically a factor of one's distance from the equator. This is climatic variation with respect to _____.

6. Mercury's rotation and revolution are locked in a rigid dance, such that the location exposed to the noonday sun at perihelion will also be exposed to the noonday sun at perihelion exactly _____ Mercury revolutions later. This is called **spin-orbit coupling**, and for Mercury it is in a ratio of 3:2.

7. For every _____ revolutions around the sun, Mercury makes exactly _____ rotations on its axis.

8. The positions which are located directly under the sun at perihelion receive 2.5 times the insolation (energy from the sun) than the locations which appear under the sun at aphelion. Because of Mercury's locked rotation/revolution, two key equatorial regions are alternately exposed to the noonday sun at perihelion. One of these hot spots is named _____.

9. Mercury, not only has the traditional climatic variations which occur with distance from the equator, like the Earth, but Mercury also experiences climatic variations because of a location's _____ position.

10. ***Mariner 10*** photographed only half of the surface area of Mercury, yet it made three flybys of the planet before becoming nonoperational. Why was this situation the best NASA could hope for with respect to the amount of territory viewed? Remember, the satellite's period was 178 days, twice the period of revolution for Mercury.
    _____
    _____
    _____

11. The counterclockwise revolution of a body around the sun causes the sun and planets to move in a (an) _____ direction among the stars.

12. The counterclockwise (west to east) rotation of a planet causes the stars and the sun to rise in the _____ and set in the _____ as witnessed by an individual viewing the sky from the surface of that body. This motion, as seen in the sky, is in a CLOCKWISE/COUNTERCLOCKWISE (circle one) direction.

13. At Mercury's hot spots (and everywhere on the planet) the sun rises in the _____. As Mercury approaches perihelion and the sun approaches its noontime position, the sun's eastward motion due to the planet's revolution becomes greater than east to west motion caused by rotation. This makes the sun appear to stop its motion, then _____ for a period of seven days. After this interval the sun's apparent westward motion due to rotation once again exceeds the sun's apparent eastward motion due to revolution. The sun slowly heads for its setting position many weeks later in the _____.

14. The geological history of Mercury is similar to Earth's moon. Use the information presented below to prescribe an evolutionary sequence in chronological order for the moon and for Mercury. Note the differences.
    a. Crustal formation and crater saturation
    b. Impact of large asteroid bodies
    c. Accretion from the cooling solar nebula
    d. Planet becomes a geologically dead world
    e. Period of planet-wide volcanism

    Moon: _____, _____, _____, _____, _____
    Mercury: _____, _____, _____, _____, _____

15. Just like Earth, Mercury's average density is presumed to be much GREATER/LESSER (circle one) than its surface density. This can only lead to the conclusion that Mercury is a **diff**_____ world. It can be said that all of the planets and most of the moons in our solar system were massive enough to be hot enough in their early histories to have produced this phenomenon.

16. When a person loses weight too rapidly, the surface area of that individual INCREASES/DECREASES (circle one) faster than the elasticity of the skin can compensate. The result is an unwanted dermatological condition known as _____.

17. It is assumed that the same situation occurred on Mercury. The planet cooled more rapidly because it was small. The core shrank, and the surface wrinkled to compensate for the decrease in surface area. Geologically, these wrinkles on Mercury are called _____.

18. State one reason why Mercury should not possess a magnetic field, even through it has been proven that one does exist. _____
_____

19. One theory contends that the dipolar magnetic field surrounding Mercury resulted when portions of its nickel-iron core _____ and assumed the magnetic field which was still being generated in deeper portions of the body. This type of "leftover" magnetic field is called _____ magnetism. Currently, there has been a return to a more traditional concept regarding the production of Mercury's magnetic field. Some geologists now believe that a portion of Mercury's core is still hot enough to be maintained in a liquid phase. Because of Mercury slow rotation the field strength would be very WEAK/STRONG (circle one).

VENUS

20. Since the mass, volume, and density of Venus are so similar to the _____, one would surmise that Venus should possess a partially melted core. Yet Venus does not have a magnetic field in the traditional sense. What characteristic, which is associated with planets that have magnetic fields, is missing with Venus?
_____

21. What little magnetic field Venus does possess is really more of a sunward generated atmospheric phenomenon. Plasma from the sun, known as the _____, ionizes the upper Venusian atmosphere creating a shock front and ionopause. This "field" causes the deflection of some of the ionized particles which approach it. If asked whether Venus possess a magnetic field, you should respond with a YES/NO (circle one) answer.

22. A train blowing its whistle approaches, then passes an observer. Describe what is heard by the stationary observer with respect to the pitch (highness or lowness) of the whistle.
    a. Train approaches: _____
    b. Train recedes: _____

23. The phenomenon, as described in the answer to the last question, is known as the _____ of sound.

24. As the train is approaching, the sound waves in front of it are being compressed. In other words, the wavelengths of the sound are being SHORTENED/LENGTHENED (circle one), thus allowing more wave crests to be intercepted by the ear of the observer each second. The more wave crests passing an observer per second, the HIGHER/LOWER (circle one) will be the pitch. The number of wave crests passing an observer per unit time interval is known as the _____.

25. As the train passes the observer, the sound waves reaching the observer's ear are lengthened. Fewer wave crests pass a given location per second. The pitch is _____.

26. The Doppler shift works the same way with all of the different forms of radiation in the _____ spectrum. Remember that sound is a compressional wave and needs a medium through which it is transported. EM energy can also be propagated through a vacuum. In the case of Venus (and Mercury), _____ (a specific type of radiation) was transmitted from Earth and reflected off the planet's surface. From one side of Venus the wavelengths of returning energy were slightly shorter than those originally transmitted, indicating movement of the planet TOWARDS/AWAY (circle one) the observer. From the other limb the reflected wavelengths of energy were slightly longer, indicating movement TOWARDS/AWAY (circle one) from the viewer. This was conclusive enough proof to show that Venus (and Mercury) _____.

27. Planets such as Venus, Earth, and Mars, probably had their primordial atmospheres stripped from them in the initial stages of the birth of the sun. These bodies would have obtained new atmospheres through the process of _____.

28. Name some of the gases that would have accumulated in the atmosphere of Venus, based upon your answer to the last problem.

    a. _____ c. _____
    b. _____ d. _____

29. A particular gas on Venus called _____ is chiefly responsible for artificially elevating temperature on the planet. The temperature on Venus is approximately _____.

30. Venusian volcanoes probably outgassed as much water vapor as terrestrial volcanoes, yet Venus evolved so differently from Earth. Higher initial temperatures prevented water from condensing, forming clouds, and _____ on the planet. Water was driven to higher altitudes where it was _____ by ultraviolet energy from the sun, allowing the hydrogen to escape. The _____ most likely combined with other molecules and atoms, thus further drying the atmosphere of the planet. Because the Earth experienced an epoch of rain, CO_2 was dissolved into the rainwater where it was able to enter the groundwater to form carbonate rocks, such as limestone, and be incorporated into the formation of bones, and the shells of marine life.

31. If the calcium carbonate ($CaCO_3$) rocks of Earth could be made to release their carbon dioxide (CO_2) content, this planet's atmosphere would contain about the _____ quantity of CO_2 as Venus. In this scenario the Earth's oceans would eventually boil away creating an additional 300 atmospheres over the 90-100 atmospheres released from the carbonate rocks. See below.

32. On Earth the temperature is raised about 63° F (35° C) over what it would normally be without an atmosphere. This phenomenon is called the _____.

33. Gasses, such as carbon dioxide (CO_2), water vapor (H_2O), methane (CH_4) and sulfur dioxide (SO_2) allow incoming visible _____ (type of EM) radiation to reach the surface directly. This energy is absorbed, heating the surface, and is reemitted as _____ radiation which these aforementioned gasses efficiently absorb, preventing the rapid escape of this radiation back into space.

34. The pressure exerted by the atmosphere of Venus is _____ times greater than the pressure exerted by Earth's atmosphere. This fact is also partially responsible for the high temperatures on the surface of this planet.

35. When a pocket of gas is heated, it begins to EXPAND/CONTRACT (circle one), thus causing a change in its density with respect to the gases which surround it. The pocket of gas now weighs MORE/LESS (circle one) than the "cooler" gases surrounding it, and the gas pocket begins to rise. This method of energy transport is called _____.

36. On Venus with its extremely massive atmosphere, the gases near the surface of the planet must be heated to very high temperatures before they can begin to push... (complete the thought) _____
_____
This is another factor to support why Venus is so hot at its surface.

37. Venus has multilayered cloud and haze zones which are predominantly composed of _____ droplets. Don't get confused by the composition of the clouds and the atmospheric composition of Venus which is primarily _____.

38. Liquid aerosol droplets condense in the upper levels of the Venusian atmosphere where conditions are cooler. They begin to fall towards the surface of the planet. As they descend, _____ and pressures increase. Eventually at about 30 miles above the surface of the planet level, TEMPERATURE/PRESSURE (circle one) wins over and the sulfuric acid vaporizes to begin journeying upward, where it will eventually condense to repeat this endless cycle.

39. Because the equatorial regions of Venus receive the greatest amount of energy, heat must be transferred from the _____ to the _____. However, unlike the more complicated patterns of Earth, Jupiter, and Saturn, the Venusian atmosphere circulates in basically a ONE/TWO/THREE/FOUR (circle one) celled structure. The same Coriolis effect deflects the atmosphere of Venus.

40. The simpler circulation pattern of the Venusian atmosphere is a result of a very slow planetary _____ rate.

41. The surface of Venus is a WINDY/CALM place. However, at the top of the Venusian atmosphere, the clouds are circulating around the planet in a period of only _____ days. They circle Venus in the DIRECTION/OPPOSITE DIRECTION (circle one) of the planet's rotation.

42. The ***Pioneer-Venus Orbiter*** deduced that the surface of Venus had a varied topography. The satellite reflected radar waves from the planet's surface and noted the varying time _____ in the returned signal. Higher landforms reflected the signal back to the spacecraft in a SHORTER/LONGER (circle one) duration than landforms which were lower.

43. The latest high tech spacecraft which was performing the same type of radar mapping, only in more detail, was named _____.

44. In general terms, the surface topography (elevation of landforms) on Venus is relatively FLAT/MOUNTAINOUS (circle one). Keep in mind that the tallest mountain on Venus, Maxwell Montes, a volcano, is about 7000 feet (2100 m) higher than Everest, the tallest mountain on Earth (30,000 feet or about 9000 meters).

45. Magellan has shown in startling detail the dynamic surface features of Venus which possess volcanoes, massive lava flows, mountain ranges, and deep chasms. There are few impact craters on Venus' surface as compared to other terrestrial planets, such as Mercury and Mars. This would indicate that Venus' surface is geologically YOUNGER/OLDER (circle one).

46. Radar images of the surface of Venus appear bright and dark, just like in a conventional black and white photograph. However, their interpretations are very different. Locations where the ground is rough appear BRIGHTER/DARKER on a radar image, whereas a smooth surface is a poorer reflector of energy and is portrayed as _____.
47. On a radar image, lava flows emanating from a volcano would appear _____, while the melted rock found inside of a large impact crater would look _____.

48. One unique geologic feature found only on Venus is called Pancakes. They are volcanic domes, but very broad and flat. An explanation for their flatness has been attributed the crushing effects of Venus's _____.

49. For the incredible amount of volcanic activity which is occurring or has occurred on Venus, it might be thought that Venus's surface would be divided into a series of crustal plates similar to Earth. However, on Venus there does not appear to be any extensive convergent, divergent, or transform plate boundaries like the Earth possesses. The process by which Venus releases its internal heat appears to be similar to localized regions on the surface of the Earth. One of these areas is the island group of the Hawaiian Islands. The type of activity which is happening here is called _____ volcanism.

50. Considering the three major rock types, and what has been mentioned above, one would expect to find only IGNEOUS/SEDIMENTARY/METAMORPHIC (circle one) rocks in great abundance on Venus's surface. _____ rocks would be expected to be absent because Venus lacks any water. This is exactly what the Russian Venera landers discovered when they photographed the surface from close range.

MARS

51. Mars was once considered to be the abode of life because there are so many similarities between it and the earth. Name three of these basic similarities which could be deduced from **telescopic** observations of the planet. Mass, volume, density and composition will not be accepted.
    a. _____
    b. _____
    c. _____

52. The Italian astronomer Giovanni _____ (1835-1910) first noticed strange linear features on Mars which he called _____.

53. The American astronomer, Percival _____ founded an observatory in Flagstaff, Arizona, (near the Grand Canyon) to investigate the possibility of _____ on Mars.

54. He believed that Mars possessed a dying civilization that lived near the equator of the planet. These "creatures" were pumping water from the two Martian polar caps via a planet-wide network of _____ that were faintly visible from earth.

55. NASA Mariner probes of the late 1960's (Mariner 4--1965, Mariners 6 and 7--1969) revealed a Mars that looked very much like (the) _____.

56. When Mariner 9 went into orbit around Mars in 1971, it revealed a world that possessed _____, _____, and _____. Gone were the canals, but in their place a dynamic and evolving planet was substituted.

57. The search for life on Mars continued with the _____ program which landed two robotic spacecraft on the Martian surface in 1976.

58. The Landers failed to detect any _____ molecules in the soil which would have suggested that life existed on the Red Planet.

59. There were three life experiments that were performed on the surface of Mars by each of the Viking landers. One test took Martian soil and fed it with all of the nutrients which plant life could possibly want. Sensors in the chamber were designed to monitor changes

in the gas content that would signal that there was life in the soil. What kinds of changes were NASA scientists looking for? _____
_____

60. The second life experiment moistened a sample of Martian soil with nutrients tagged with radioactive carbon-14. If the soil contained animal life, these life forms would metabolize the foodstuffs and release waste gases back into the chamber. What were scientists looking for in this experiment to show that animal life existed on the planet Mars?
_____
_____

61. The third life experiment provided a soil sample with the equivalent of Martian sunlight minus the _____ radiation that would be striking the surface of the planet. Radioactive carbon 14 gas was put into the chamber, and it was hoped that if life did exist in the soil the living organisms would ingest some of the carbon-14. After a period of time, the container was evacuated and then heated to a temperature where the organic molecules would have been broken down and vaporized. How would scientists have detected that life processes were occurring after the sample was vaporized?
_____
_____

62. Make a statement concerning the significance of the Mars Viking probes in light of the biology experiments. _____
_____

63. In August of 1996, a NASA research team at the Johnson Space Center and at Stanford University announced that there was evidence that strongly suggested primitive life may have existed on Mars more than 3.6 billion years ago. The NASA-funded team found the what they thought to be the first organic molecules thought to be of Martian origin; several mineral features characteristic of biological activity; and possible microscopic fossils of primitive, bacteria-like organisms inside of an ancient Martian rock that fell to Earth as a _____. The specimen was "lobbed off" Mars about 15 million years ago. The most recent conclusion on this sample is that it did not contain any lifeforms.

64. Pathfinder landed on Mars in 1997 with the first roving robotic craft. This spacecraft was directly inserted into the Martian atmosphere, braked by parachute and rockets, and finally allowed to bounce to a landing on the surface protected by a padding of inflatable _____.

65. Pathfinder was followed by a series of _____ (type of spacecraft), NASA's Mars Odyssey and Mars Global Surveyor, as well as the European Space Agency's, Mars Express, which began high-resolution surveys of the Martian surface.

66. Finally in late 2003 and early 2004 two Mars Exploration Rovers were deployed to the Martian surface in a similar fashion as Pathfinder. The most significant discovery make by these robots was that _____
_____

67. Martian seasonal changes which affect the contrast of Martian surface features and are probably the result of the movement of debris by the _____.

68. Geologists searching the returned photographic data for evidence that water had flowed over the surface found lots of evidence, such as:
    a. _____
    b. _____
    c. _____

69. State at least one piece of scientific evidence returned from the Mars Exploration Rovers, Spirit and Opportunity, to indicate that water was once present at the landing sites.
    _____

70. Changes brought about by wind could be identified on the planet's surface by observing
    _____

71. The Tharsis Ridge, where many of Mars' volcanoes are found, is a domed up area where _____ intruded and lifted the overlying layers several kilometers above the mean surface level of the planet. The Tharsis Ridge is located in Mars' equatorial region.

72. When ground is domed up by huge underground sources of magma, the surface layers stretch until they reach their breaking point. Then they fracture along generally straight lines forming what geologist call _____.
73. Probably the best example of this process on the planet Mars and in the solar system is called V_____ M_____ or the Grand Canyon of Mars. It is about 2500 miles (4000 km) in length. It may also represent a divergent plate boundary suggesting that Mars, for a very short period of time, experienced _____.

74. Where the surface became most fractured, deep faults allowed magma to rise to the surface and form_____ (geologic feature) on the Tharsis Ridge.

75. The largest of these is called _____. It is 15 miles in elevation and 375 miles in diameter (24 km by 600 km). At the summit there is a _____ which is 40 miles (60 km) in diameter and which may have formed when magma retreated from the summit area of the volcano and that portion of the volcano _____. There is another theory regarding the formation of caldera that states that the summit of the volcano, which has a slightly higher density, simply sinks into a reservoir of magma below it.

76. The lava that formed Olympus Mons had a HIGH/LOW (circle one) viscosity. Remember that viscosity is the resistance to flow that a material possesses in the liquid phase.

77. A volcano such as Olympus Mons could not exist on the Earth. It most likely would _____. Since these huge volcanoes do exist on Mars, it can be assumed that the crust is _____. Another mitigating circumstance is that the gravitational attraction on Mars is weaker.

78. Coming off of the Tharsis Ridge and stretching away from the volcanic zone is a great rift valley called _____. It is about 2500 miles (4000 km) in length. It is probably related to Tharsis, having also been caused by the upward pressure of magma working its way towards the surface. This pressure may have been released when a graben fault formed.

79. Mars possesses an atmosphere that is primarily composed of _____.

80. Like Venus, Mars' atmospheric temperature is raised because it retains some of the _____ energy (specific type) that is radiated from its surface. Mars' temperature is raised by only 9° F (5° C), compared to a huge 900° F (500° C) for Venus. The difference in the ability of the greenhouse effect to raise the temperature of Mars' atmosphere is a result of that atmosphere's low _____.

81. In fact the temperature of the ground at the equator during summer can climb to 80 degrees F., but just three feet (one meter) above the surface the temperature is _____.

82. Mars has many different ways in which the atmosphere circulates. One of the most interesting and unique patterns has to do with the freezing and subliming (vaporizing) of _____ at the polar caps. As winter approaches and temperatures lower, _____ is deposited as dry ice on the surface at one of the poles. The atmospheric pressure in that region INCREASES/DECREASES (circle one). Just the opposite situation is occurring at the other pole, so the pressure in that region INCREASES/DECREASES (circle one). Atmosphere is transported from the pole that is WARMING/COOLING (circle one) to the other pole via a pressure gradient that is formed between these two regions.

83. One might expect that during the time periods when the Martian atmosphere is being transported from one pole to the other that huge _____ can be seen across the surface of Mars.

Name _____ Date _____ Moravian University

Name _____ Name _____

The Martian

(10 points)

"I'm pretty much f**ked (says astronaut, Mark Watney). That's my considered opinion. F**ked! Six (Martian) days (Sols) into what should be the greatest two months of my life, and it's turned into a nightmare." That's how Andy Weir's novel, ***The Martian,*** begins. But Mark Watney has no desire to die on Mars and begins a heroic effort to save himself. His problems seem insurmountable, but he tackles them one problem at a time and in a predetermined order eventually to… I can't tell you what really happens. That would spoil the film. Here's what I want you to do. Jot list his problems and how he solves them. After seeing ***The Martian***, work in groups to brainstorm the assignment. Also, if you see something which you believe is in error, list it and tell me what would make it incorrect. Check either the problem or error box and then state your reasons in the large rectangular space. We will discuss your results briefly when we meet in our next regularly scheduled class.

Problem	Error	State the problem and how is it solved or state the error which you saw.
1.		
2.		
3.		
4.		
5.		
6.		

Problem	Error	State the problem and how is it solved./State the error which you saw.
7.		
8.		
9.		
10.		

If you can go beyond 10, do it for extra credit!

Problem	Error	State the problem and how is it solved./State the error which you saw.
11.		
12.		
13.		
14.		

ANSWERS TO SESSION TEN QUESTIONS

MERCURY

1. 36 million (58 million km), 88
2. a. new
   b. full
   c. quarter
3. craters
4. ***Mariner 10***, ***MESSENGER***
5. latitude
6. two
7. two, three
8. Caloris (the Caloris basin)
9. longitude
10. The ***Mariner 10*** orbital period of 178 days equals twice the revolutionary period of Mercury. In that time, Mercury makes exactly three rotations, presenting exactly the same face towards the sun for photography by the spacecraft.
11. eastward (counterclockwise), CLOCKWISE
12. east, west
13. east, move backwards (retrograde), west
14. a. Moon: C, A, B, E, D
    b. Mercury: C, A, E, B, D
15. GREATER, differentiated
16. DECREASES, wrinkles
17. lobate scarps
18. It rotates too slowly. Its nickel-iron core may be solid.
19. solidified, remnant, WEAK

VENUS

20. Earth, rapid enough rotation
21. solar wind, NO
22. a. Train approaches: high pitch
    b. Train recedes: lower pitch
23. Doppler shift
24. SHORTENED, HIGHER, frequency
25. lower
26. electromagnetic, radio waves (microwaves), TOWARDS, AWAY, rotated
27. volcanism
28. a. nitrogen (from NO, NO_2 and HNO_3)
    b. argon (from radioactive Potassium 40)
    c. carbon dioxide (CO_2)
    d. sulfur dioxide (SO_2)
    e. water (H_2O)
    f. carbon monoxide (CO)
29. carbon dioxide, 900° F (500° C)
30. raining, photodissociated, oxygen
31. same
32. greenhouse effect

33. visible, infrared
34. 90
35. EXPAND, LESS, convection
36. aside the overlying layers of atmosphere and rise.
37. sulfuric acid, carbon dioxide
38. temperatures, TEMPERATURE
39. equator, poles, ONE
40. rotation
41. CALM, four days, DIRECTION
42. delays (intervals), SHORTER
43. ***Magellan***
44. FLAT (Rolling hills account for about 60% of Venus's surface, while lowlands are about 30%, and mountainous terrain about 10%)
45. YOUNG
46. BRIGHTER, darker
47. bright, dark
48. atmosphere (90 times the pressure of Earth's atmosphere)
49. hot spot
50. IGNEOUS, sedimentary

MARS

51. a. similar axial tilt
    b. observable seasonal changes
    c. polar caps
    d. canals
    e. similar rotational period
52. Schiaparelli, "canali"
53. Lowell, life
54. canals
55. moon
56. volcanoes, huge canyons, river channels, sand dunes, evidence of mechanical erosion by wind
57. Viking
58. organic
59. An increase in the amount of oxygen in the chamber was due to photosynthesis. There was a marginally positive response after an initial burst of oxygen released.
60. Waste gases would contain radioactive Carbon-14 that could be detected in the atmosphere of the chamber using a Geiger counter. The experiment gave a spiked positive response that was not present after other soil samples were sterilized by preheating.
61. Ultraviolet. Upon heating the chamber, the metabolized Carbon-14 would have been released and could have been detected with a Geiger counter. This experiment gave a negative response.
62. The possibility of life on Mars still cannot be completely ruled out. However, the probability that Mars does have life where the Viking spacecraft landed has been diminished. The absence of organic molecules in the Martian soil was the most significant blow to the life theory.
63. meteorite
64. balloons. Mercury could also be an arguable answer.

65. orbiters
66. Mars contained abundant supplies of water in its distant past.
67. wind
68. a. dendritic (root-like) channels
    b. outwashing from slumped regions
    c. teardrop shaped features
    d. braided flowage patterns
    e. craters surrounded by mud-like outflows
69. a. rounded concretions dubbed "blueberries" about the size of BBs contain hematite, an iron-based mineral. Hematite usually forms in a wet environment.
    b. Hematite concretions only form in a wet environment.
70. streaked patterns, sand dunes, changes in albedo due to dust covering and uncovering areas of the planet. Many dust storms have been seen on the planet from satellite imagery, as well as from the Earth. Dust devils and their tracks have also been photographed from space.
71. magma
72. grabens, rilles (straight)
73. Valles Marineris, continental drift, or plate tectonics.
74. volcanoes
75. Olympus Mons, caldera, collapsed
76. LOW
77. sink into the mantle (asthenosphere) of earth, thicker

78. carbon dioxide
79. infrared, density--thinness of the Martian atmosphere... There are simply less air molecules to absorb the heat that is radiated back towards space from the Martian surface. Mars is also much farther from the sun, so it receives much less energy than Venus.
80. CO_2, CO_2, DECREASES, INCREASES, WARMING
81. dust storms

October 11, 2015

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