ISP 205: Visions of the Universe Summer 2004

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Sample Questions

1. Most primitive ideas about the universe pictured
   A. the stars as distant suns.
   B. the creation as starting with a huge explosion.
   C. the Sun as the center of the universe.
   D. the Moon as going around the Sun.
   E. the Earth and sky as being roughly the same size.

2. The term Zodiac refers to
   A. all constellations named after animals.
   B. the light from Saturn's rings.
   C. a method for making astrological predictions.
   D. the head of the Celestial Empire.
   E. a group of constellations lying near the ecliptic.

3. In current scientific opinion, Stonehenge is considered to have been
   A. an ancient flying saucer base.
   B. the site of early Christian rituals.
   C. the site of ancient fertility rites.
   D. an ancient burial ground.
   E. an astronomical observatory.

4. During the course of a year, the Sun appears to travel once around the sky along
   A. the equator.
   B. the ecliptic.
   C. the horizon.
   D. the meridian.
   E. None of the other answers listed here is correct.

5. If the Moon is very close to a certain star in the sky, how long will it be before the Moon is again close to the same star?
   A. 23 hours 56 minutes
   B. one week
   C. one year
   D. one month
   E. 24 hours

6. Retrograde motion of a planet can be described as a temporary reversal of the planet's
   A. rotation.
   B. revolution.
   C. normal east to west motion compared to the stars.
   D. normal west to east motion compared to the stars

7. In ancient times, how did people primarily tell the difference between planets and stars?
   A. The planets showed phases.
   B. The planets looked bigger.
   C. The planets didn't twinkle.
   D. The planets moved relative to the stars.
   E. None of the other answers is correct.

8. Most Greek astronomers believed that the Earth is immobile because they did not observe
   A. parallaxes for the stars.
   B. retrograde motion of the planets.
   C. stellar motion.
   D. eclipses of the Sun.
   E. All of the other answers are correct.

9. In the ancient geocentric view of the universe, the Earth was surrounded by a celestial sphere that
   A. never moved.
   B. rotated from east to west each day.
   C. was thousands of times larger than the Earth.
   D. took one year to rotate around the Earth.
   E. rotated from west to east each day.

10. In the geocentric concept if the universe, which direction does the celestial sphere appear to rotate about the stationary Earth? In the heliocentric universe, which direction does the earth rotate?
    A. geocentric: west to east; heliocentric: west to east
    B. geocentric: east to west; heliocentric: west to east
    C. geocentric: east to west; heliocentric: east to west
    D. geocentric: west to east; heliocentric: east to west

11. The Greeks developed the idea that the sky had depth, with some celestial objects being farther away than others, by understanding
    A. the cause of the seasons.
    B. retrograde motion of the planets.
    C. eclipses.
    D. that the Earth is round.
    E. the rotation of the Earth.

12. Aristotle concluded that the Earth is spherical from the curvature of its shadow on the
    A. Moon during a solar eclipse.
    B. Moon during a lunar eclipse.
    C. Earth during a lunar eclipse.
    D. Earth during a solar eclipse.
    E. Sun during a solar eclipse.

13. Aristarchus argues
    A. for a heliocentric universe.
    B. that planets move on epicycles.
    C. for a flat Earth.
    D. that the Sun is twice as large as the Moon.
    E. for a geocentric universe.

14. Aristarchus decided that the Sun was bigger than the Moon because he knew that the sun
    A. appears much larger in the sky than the Moon.
    B. is farther than the moon, but appears the same size.
    C. is the center of the solar system.
    D. appears to move more slowly than the Moon.

15. Aristarchus estimated the relative distances of the Sun and Moon by observing the
    A. shape of the Earth's shadow on the Moon.
    B. apparent size of the Sun and Moon.
    C. angle between the half Moon and the Sun in the sky.
    D. shape of the crescent Moon.
    E. time it took a letter to reach the Sun and Moon.

16. On the assumption that the Earth is spherical, Eratosthenes estimated the Earth's circumference from measurements made at Alexandria and Syene that depend upon
    A. the direction of the Sun.
    B. the distance to the Sun.
    C. the apparent size of the Sun.
    D. the brightness of the Sun.

17. The difference in the lengths of shadows simultaneously cast by identical sticks placed vertically in the ground at two different points on a meridian indicates that
    A. the Sun is spherical.
    B. the Earth is spherical.
    C. the Earth is not flat.
    D. the Moon is spherical.

18. In order to account for the retrograde motion of the planets, Ptolemy introduced the
    A. epicycle.
    B. center of eccentric.
    C. deferent.
    D. equant.
    E. ecliptic.

19. In Ptolemy's view of the universe,
    A. the Sun moved in an elliptical orbit.
    B. the Moon could have craters but not mountains.
    C. Kepler's Harmonic Law still worked.
    D. Jupiter had four satellites.
    E. Venus would never be close to the full phase

20. In the Copernican theory, day and night are accounted for by
    A. the revolution of the Sun about the Earth.
    B. the rotation of the Earth.
    C. the revolution of the Earth about the Sun.
    D. the rotation of the Sun.
    E. the rotation of the celestial sphere.

21. Ptolemy and Copernicus both
    A. believed Mars would look faintest when at opposition.
    B. used uniform circular motion to explain planetary motion.
    C. believed the Earth went around the Sun.
    D. made very accurate predictions of planetary motion.
    E. believed the Sun went around the Earth.

22. The Copernican universe has in order of increasing distance from the sun
    A. Mercury, Venus, Mars, Earth, Jupiter, Saturn.
    B. Earth, Venus, Mars, Mercury, Saturn, Jupiter.
    C. Venus, Mercury, Earth, Saturn, Mars, Jupiter.
    D. Mercury, Venus, Earth, Mars, Jupiter, Saturn.

23. The Copernican model of the solar system allowed, for the first time, the measurement of
    A. the distance of the Sun.
    B. the relative masses of the planets.
    C. the mass of the Earth.
    D. the relative distances of the planets.

24. Copernicus explained the retrograde motions of the planets by proposing that
    A. the closer a planet is to the sun, the faster it moves.
    B. the Earth orbits the Sun faster than the other planets.
    C. the Earth rotates on its axis once a day.
    D. gravity stops planets and makes them move backwards.
    E. planets move on elipticals.

25. By using a Heliocentric model for the solar system, Copernicus was able to find for the first time the
    A. sidereal periods of the planets.
    B. cause of tides in the Earth's oceans.
    C. diameters of the planets.
    D. synodic periods of the planets.
    E. distance to the Moon.

26. Which of the following planets never reaches opposition?
    A. Saturn
    B. Venus
    C. Jupiter
    D. Mars

27. When a planet is at superior conjunction
    A. it is the best time to observe this planet.
    B. the Sun is between the Earth and the planet
    C. it is on a line between the Earth and the Sun.
    D. the Earth is on a line between the Sun and the planet.

28. If Venus is seen in the west after the Sun sets, next morning it will
    A. rise after the Sun rises.
    B. rise before the Sun.
    C. go behind the Sun.
    D. appear to have a considerably different phase.
    E. Venus is never in the west after sunset.

29. When Venus is at greatest elongation it's phase is
    A. crescent
    B. quarter
    C. gibbous
    D. gibbous or crescent

30. Venus is closest to Earth at
    A. opposition.
    B. quadrature.
    C. inferior conjunction.
    D. superior conjunction.
    E. greatest elongation.

31. When Mars is observed to be at western quadrature, an observer on Mars would see the Earth at
    A. greatest eastern elongation.
    B. inferior conjunction.
    C. greatest western elongation.
    D. opposition.
    E. eastern quadrature.

32. The planets Jupiter, Mars and Saturn are closest to the Earth when
    A. at quadrature.
    B. They are always at the same distance from the Earth.
    C. at opposition.
    D. at conjunction.

33. The time between oppositions of Mars is known as Mars'
    A. rotation period.
    B. eccentric period.
    C. sidereal period.
    D. period of revolution.
    E. synodic period

34. Pluto takes nearly 249 years to go around the Sun. The time between oppositions of Pluto would be
    A. a little longer than one year.
    B. 249 years.
    C. a little shorter than 249 years.
    D. a little shorter than one year.
    E. A little longer than 249 years.

35. The astronomer Tycho Brahe was known for his,
    A. measurement of the Earth's rotation.
    B. use of the telescope.
    C. accurate observations of planet positions.
    D. observation of the Moon's features.
    E. theory of epicycles.

36. The discovery that planets move in elliptical orbits with the Sun at the focus was made by
    A. Galileo.
    B. Tycho Brahe.
    C. Kepler.
    D. Giordano Bruno.
    E. Halley.

37. Kepler's second law states that the line joining the Sun to a planet
    A. sweeps out equal areas in equal times.
    B. covers equal distances in equal times.
    C. covers an area equal to the cube of its length.
    D. moves more slowly the closer it is to the Sun.
    E. None of the choices given here is correct.

38. A planet moves faster in its orbit
    A. when it is in opposition.
    B. when it is farthest from the Sun.
    C. the farther it is from it's satellites.
    D. when it is nearer the Sun.
    E. the greater its mass.

39. Kepler's third law states that the square of the orbital period of a planet is proportional to
    A. its mass squared.
    B. its density squared.
    C. its orbital semimajor axis cubed.
    D. the reciprocal of its orbital semimajor axis.
    E. the orbital semimajor axis.

40. If there had been no oceans on the Earth, the Earth's present atmosphere would be largely composed of
    A. carbon monoxide
    B. nitrogen
    C. water
    D. oxygen
    E. carbon dioxide

41. The oldest rocks thus far found on the Earth's surface have ages of about
    A. 3.5 billion years
    B. 3.5 million years
    C. 3.5 thousand years
    D. 35 years

42. The first use of the telescope for astronomical observations was made by
    A. H. Kissenger
    B. Kirchhoff
    C. Tycho Brahe
    D. Galileo
    E. Newton

43. Galileo's studies of moving objects led to the idea that a moving object
    A. requires a force to keep it moving.
    B. comes to rest only if a force stops it.
    C. will seek its natural state of rest.
    D. is subject to the Universal Law of Gravity.
    E. will go faster the heavier it is.

44. The phases of Venus were discovered by
    A. Galileo.
    B. Tycho.
    C. Copernicus.
    D. Ptolemy.
    E. Kepler.

45. The four large moons around Jupiter were discovered by
    A. Galileo.
    B. Ptolemy.
    C. Tycho Brahe.
    D. Kepler.
    E. Copernicus.

46. Galileo's observation that Venus shows all of the phases was important because it discredited
    A. the Copernican theory.
    B. the Ptolemaic theory.
    C. Newton's law of gravitation.
    D. Kepler's Harmonic Law.

47. Galileo demonstrated that when a heavy and a light body are dropped at the same instant and correcting for the effect of air resistance
    A. they fall exactly at the same rate.
    B. they behave exactly as Aristotle predicted.
    C. the lighter one falls faster.
    D. they fall at rates proportional to their weights.

48. The rate of change of the velocity of a body is called the body's
    A. acceleration.
    B. mass.
    C. applied force.
    D. momentum
    E. kinetic energy.

49. Newton's Second Law of Motion showed that the acceleration of a body depends on
    A. its mass and the force on it.
    B. its mass and velocity.
    C. its velocity and the force on it.
    D. its velocity and the amount of friction.
    E. its velocity and density.

50. "For every action there is an equal and opposite reaction" is a statement of
    A. Galileo's theory of motion.
    B. Newton's third law of motion.
    C. the correspondence principle.
    D. Kepler's first law of planetary motion.
    E. the theory of relativity.

51. Newton's law of gravitation states that the attractive force between any two masses in space is in proportion to the product of the (1)_____ and in inverse proportion to the square of the (2)_____.
    A. (1) masses; (2) distance between them
    B. (1) distances between them; (2) masses
    C. (1) reciprocal distances between them; (2) masses
    D. (1) inverse masses; (2) distance between them

52. A planet moves faster at
    A. quadrature.
    B. aphelion.
    C. perihelion.
    D. conjunction.

53. The Earth has an equitorial bulge because of
    A. the gravitational pull of the Sun.
    B. the gravitational pull of the Moon.
    C. the Earth's revolution around the Sun.
    D. the Earth's precession.
    E. the Earth's rotation.

54. An important cause of the slowing down of the Earth's rotation is the
    A. pull of the Earth's equitorial bulge on the Moon.
    B. gravitational increase in the size of the Earth's orbit.
    C. tides caused by the gravity of the Moon.
    D. pull of the Moon on the Earth's equitorial bulge.
    E. pull of the Moon on the Earth's magnetic field

55. The star Polaris will no longer be located close to the north celestial pole several thousand years from now, due to
    A. parallax and aberration of starlight.
    B. revolution of the Earth around the Sun.
    C. precession of the Earth's axis.
    D. tides in the Earth's oceans.
    E. rotation of the Earth on its axis.

56. The first physical proof of the rotation of the Earth on its axis was demonstrated
    A. by noting the differences between solar and sidereal time.
    B. by Bradley with the discovery of stellar aberration.
    C. by Galileo, when he observed the motions of Jupiter's moons.
    D. by Foucault in 1851 using the pendulum experiment.
    E. by observing the day-to-day motion of the Sun.

57. The first physical proof that the Earth revolves in an orbit about the Sun was afforded by
    A. the daily rising and setting of most celestial bodies.
    B. Bradley's demonstration of the abberation of starlight.
    C. the parallactic motion of the stars during a year.
    D. the demonstration of the coriolis force.
    E. Foucault's pendulum experiment.

58. Which of the following is a proof of the Earth's revolution around the Sun?
    A. the Foucault pendulum experiment.
    B. parallax of stars.
    C. rising and setting of the Sun.
    D. seasons.

59. Because of the precession of the equinoxes
    A. "Winter" constellations will someday be seen in summer.
    B. the Vernal Equinox moves with respect to the stars.
    C. the declinations of the stars change slowly with time.
    D. Polaris will not always be our pole star.
    E. All of these answers are correct.

60. If the Earth did not have an equitorial bulge
    A. its rotational axis would not precess.
    B. the Earth's orbit would be perfectly circular.
    C. seasons on Earth would be much less extreme.
    D. the Earth would no longer be subject to tidal forces.
    E. eclipses of the Moon would occur more frequently.

61. One side of the Moon always faces the Earth because the
    A. rotation rate about the Sun equals the revolution rate.
    B. Earth always has the same side facing the Moon.
    C. revolution rate about the Earth equals the rotation rate.
    D. Moon does not spin on its axis.

62. At the time of a lunar eclipse, the phase of the Moon must be
    A. new
    B. full
    C. gibbous
    D. first quarter
    E. last quarter

63. Total solar eclipses, when they occur, are visible from
    A. any place on Earth where the Sun and Moon are visible.
    B. any place on the Earth.
    C. a narrow path on the Earth.
    D. any place on the Earth where the Sun is visible.

64. If the ecliptic and the orbit of the Moon were in the same plane
    A. as seen from Earth, the Moon would no longer show phases.
    B. we would see the entire surface of the Moon.
    C. the Moon would collide with the Sun.
    D. there would be a lunar eclipse each month.
    E. the Earth would cease to precess.

65. The most massive planet in the solar system is
    A. Neptune
    B. Saturn
    C. Uranus
    D. Jupiter
    E. Mars

66. Name the planet which is largest in diameter.
    A. Jupiter
    B. Venus
    C. Uranus
    D. Mercury

67. A planet is more likely to keep an atmosphere from escaping into space if its upper atmosphere is
    A. hot and the gravitational field is strong.
    B. cold and the gravitational field is strong.
    C. hot and the gravitational field is weak.
    D. cold and the gravitational field is weak.
    E. hot and the atmosphere is made of hydrogen.

68. Mars and Mercury have similar velocities of escape, yet Mars has an atmosphere and Mercury has essentially none. The difference is probably due to
    A. Mars having a slower velocity in its orbit than Mercury.
    B. Mercury having a higher surface temperature than Mars.
    C. Mercury's rotation rate being faster than that of Mars.
    D. initial differences in the compositions of the planets.
    E. None of the other answers is correct

69. Which planets have mainly carbon dioxide (CO) for an atmosphere?
    A. Venus, Earth, and Mars
    B. Venus and Mars
    C. Mars and Jupiter
    D. Venus, Mars, and Saturn
    E. Jupiter and Saturn

70. The material which is most dominant in all of the giant planets is
    A. carbon
    B. oxygen
    C. ammonia
    D. helium
    E. hydrogen

71. Where is all the carbon dioxide which should be present in the Earth's atmosphere?
    A. oceans
    B. air
    C. Earth's ice caps
    D. gone into space
    E. rocks

72. Rocks on the Moon have been shown to have ages
    A. between 10 and 20 billion years.
    B. between 6 and 8 million years.
    C. of 3.5 billion years with no range in age.
    D. They have not been dated.
    E. between 2.5 and 4.6 billion years.

73. Most lunar craters were apparently caused by
    A. volcanoes.
    B. We have no good ideas for their cause.
    C. bursting bubbles of gas from the interior.
    D. spacecraft landings.
    E. meteoric impacts.

74. Which part of the Moon is oldest?
    A. the maria.
    B. the rilles.
    C. the highlands.
    D. the maria and the highlands are the same age.
    E. the lowlands.

75. Suppose that an Apollo astronaut forgot to label one of the rock samples that he brought back to Earth. It is later dated as 4.2 billion years old. Which lunar region is it most likely to have come from?
    A. the highlands.
    B. one of the craters in the maria.
    C. one of the maria on the backside of the Moon.
    D. the smooth region in the maria

76. Most of the craters on the Moon
    A. are seen most easily at full Moon.
    B. were predicted to exist by Aristotle.
    C. occur in the younger parts of the Moon's surface.
    D. were formed in the Moon's first billion years of existence.
    E. were created by volcanoes.

77. Which of the following processes has never affected the Moon's surface?
    A. volcanoes.
    B. human footsteps.
    C. impact cratering.
    D. wind and water erosion.

78. The surface of Mercury most closely resembles
    A. the lunar maria.
    B. the surface of Venus.
    C. the Earth's surface.
    D. the Moon's surface.

79. Which of the following has little or no atmosphere?
    A. Jupiter
    B. Venus
    C. Mercury
    D. Mars
    E. Earth

80. The atmosphere of Venus has been shown to
    A. contain large amounts of methane.
    B. contain large amounts of carbon dioxide.
    C. contain large amounts of hydrogen.
    D. be very cold.
    E. be very rich in water.

81. The atmospheric pressure on the surface of Venus is about _____ times that of Earth.
    A. 8.9
    B. 0.01
    C. 100
    D. 0.9
    E. 1000

82. The surface temperature of Venus is higher than expected as a result of
    A. internal heat from radioactive decay.
    B. its proximity to the Sun.
    C. the greenhouse effect.
    D. compression of its inner regions.
    E. volcanoes.

83. One use of radar astronomy in planetary research has been to
    A. detect volcanoes on Mars.
    B. find water on Neptune.
    C. detect mountains on Jupiter.
    D. detect mountains on Venus.
    E. discover features on the Moon.

84. Lightning on Venus tends to occur where?
    A. over continents.
    B. near the north pole.
    C. uniformly over the entire planet.
    D. in rolling planes.
    E. near volcanoes.

85. The main reason the atmospheres of Venus and Earth are so different is that Venus
    A. lacks a magnetic field.
    B. lacks liquid water to remove carbon dioxide.
    C. rotates slower than the Earth.
    D. formed from much different chemicals than Earth did.
    E. has a smaller mass than the Earth.

86. The warmest temperatures on Mars are
    A. like a cold winter day in East Lansing.
    B. hot enough to melt lead.
    C. like a warm spring East Lansing day.
    D. near the boiling point of water on Earth.
    E. cold enough to freeze dry ice.

87. Extraterrestrial dust and sand storms have been observed on
    A. Venus
    B. Mercury
    C. Mars
    D. Jupiter
    E. None of these planets.

88. The gigantic volcanic mountain on Mars photographed by Mariner 9 is named
    A. Sinus Imperturbium
    B. Olympus Mons
    C. Mare Volcanorum
    D. Mare Deplorum

89. The air pressure at the Viking landing sites on Mars was about _____ percent of the Earth's normal pressure.
    A. 1000
    B. 100
    C. 10
    D. .1
    E. 1

90. The Viking landers on Mars indicated Mars has no life on it because the Vikings found
    A. poisonous gases on Mars.
    B. too little water vapor for life to survive.
    C. no sign of organic molecules in the Martian soil.
    D. temperatures too cold for life to survive.
    E. temperatures too hot for life to survive.

91. Space probes have indicated that Mars has
    A. a dense atmosphere.
    B. three moons.
    C. ice caps of frozen carbon dioxide and water.
    D. simple life forms.
    E. aurorae.

92. We believe that at one time water flowed on Mars because of observations of
    A. fossilized stern-wheeler paddle steamers.
    B. polar ice caps.
    C. erosion on rocks photographed by Viking.
    D. features which look like dried-up river beds.
    E. sedimentary rock near Mars' equator.

93. Jupiter has a noticeable equitorial bulge mainly as a result of
    A. its magnetic field.
    B. its rapid rotation.
    C. its high-speed winds.
    D. the gravitational pull of its satellites.
    E. heat escaping from its interior.

94. The Great Red Spot on Jupiter is
    A. a violent cyclonic storm.
    B. the top of a gigantic volcano.
    C. an island floating in a sea of molecular gases.
    D. sulfurous clouds over the vertex of a solid obstacle.
    E. reddish dust.

95. Jupiter's atmosphere is mostly hydrogen and
    A. neon
    B. sulfuric acid
    C. ammonia
    D. water
    E. helium

96. On which objects in the solar system have volcanos been observed actually erupting?
    A. Moon, Earth, Mars, and Jupiter
    B. Mercury, Earth, and Mars
    C. Earth and Io
    D. Earth
    E. Earth, Mars, and Io

97. The outer Galilean moons of Jupiter are thought to consist primarily of
    A. rock with a little water (liquid or solid).
    B. carbon dioxide and nitrogen.
    C. hydrogen, methane, and ammonia.
    D. metals and rock.
    E. water (liquid or solid), with some rock.

98. The inner and outer Galilean moons differ, in that
    A. the inner moons have more craters.
    B. the inner moons have fewer volcanoes.
    C. the inner moons have more ice.
    D. the inner moons have less ice.

99. The interior of Jupiter principally consists of
    A. hydrogen and helium in gaseous form.
    B. liquified and metallic hydrogen.
    C. gaseous hydrogen, rock and an iron core.
    D. methane, ammonia, and hydrogen.
    E. gaseous and liquid hydrogen and an ice-rock core.

100. Saturn's rings are most probably composed of
     A. a solid sheet of ice.
     B. ice crystals and dust grains.
     C. gas tidally pulled out of its atmosphere by its moons.
     D. asteroids.
     E. micrometeorites.

101. One satellite known to possess an atmosphere is
     A. Oberon
     B. Ganymede
     C. Ceres
     D. Phobos
     E. Titan

102. William Herschel, while mapping the sky in 1781, accidentally discovered
     A. Pluto
     B. Saturn
     C. Neptune
     D. Mars
     E. Uranus

103. Uranus must have once collided with another large object because
     A. half of the planet is missing.
     B. it has a very large impact crater.
     C. it has very large moons.
     D. it has large seas like the Moon.
     E. its rotation is very inclined.

104. Uranus appears as a greenish disk due to the presence of
     A. hydrogen
     B. methane
     C. ammonia
     D. helium
     E. nitrogen

105. The position of Neptune in the sky was predicted by Adams and Leverrier after anomalies had been observed in the orbit of
A. the satellites of Jupiter
B. Jupiter
C. the Earth
D. Uranus
E. Saturn

106. To the best of our present knowledge, the composition of Pluto is most similar to
A. Io.
B. the Earth's Moon.
C. the Jovian planets.
D. the terrestrial planets.
E. typical satellites of Jovian planets.

107. The planet that is sometimes farther from the sun than Pluto is
A. Mars
B. Mercury
C. Venus
D. Uranus
E. Neptune

108. The most eccentric and altogether peculiar orbit of any planet is that of
A. Pluto
B. Venus
C. Saturn
D. Uranus
E. Mars

109. The first person known to have looked at the heavens through a telescope was
A. Newton
B. Galileo
C. Ptolemy
D. Kepler
E. Tycho

110. Galileo discovered
A. sunspots and the Sun's rotation.
B. all of the others.
C. the mountains of the Moon.
D. the four major moons of Jupiter.
E. the phases of Venus.

111. A heavy weight dropped on the Earth is more strongly attracted by Earth's gravity than a lighter weight. However, it falls at the same rate as the lighter weight because it
   A. has the same mass as the lighter object.
   B. has more resistance due to friction with the air.
   C. has a greater resistance to acceleration.
   D. starts out farther from the Earth.
   E. attracts the Earth less than the lighter weight does.

112. Newton's Second Law of Motion states that the acceleration of a body when acted on by an external force is
   A. proportional to its density.
   B. inversely proportional to its mass.
   C. zero.
   D. independent of its mass.
   E. directly proportional to its mass.

113. The law which operates in jet propulsion of airplanes and rockets is
   A. Newton's third law.
   B. Kirchhoff's first law.
   C. Bode's law.
   D. Ptolemy's first law.
   E. Kepler's law of areas.

114. Newton's law of gravitation states that the attractive force between any two masses in space is in proportion to the (1)_____of the masses and in (2)_____ proportion to the square of the distance between them.
   A. (1) quotient; (2) inverse.
   B. (1) product; (2) inverse.
   C. (1) product; (2) direct.
   D. (1) quotient; (2) direct.

115. The masses of celestial objects are usually found from their
   A. resistance to acceleration.
   B. brightness.
   C. gravitational effects on other objects.
   D. size and density.
   E. None of the other answers would be a valid conclusion.

116. A common cause of the bulging of a planet at its equator is its
   A. rotation
   B. revolution.
   C. density
   D. composition

117. One effect of the Earth's tides is to
A. change the length of the year.
B. pull the Moon closer to the Earth.
C. slowly increase the length of our day.
D. make the Earth's axis precess with a 26,000 year period.

118. The gravity of the Moon and Sun pulling on the Earth's equitorial bulge is the best way of explaining
A. Earth's precession.
B. rotation of the Earth.
C. the slowing down of the Moon's rotation.
D. the slowing down of the Earth's rotation.
E. tides.

119. Direct evidence that the Earth rotates on its axis is
A. aberration of starlight.
B. precession.
C. parallax of stars.
D. rising and setting of the stars.
E. the Foucault pendulum.

120. Both stellar parallaxes and the aberration of starlight are a consequence of
A. the presence of the Earth's atmosphere.
B. the revolution of the Earth about the Sun.
C. the rotation of the Earth.
D. the precession of the Earth's axis.
E. the inclination of the ecliptic to the equator.

121. We cannot see the entire surface of the Moon from Earth because
A. one side of the Moon is dark.
B. the Moon rotates once for every revolution.
C. there is nothing behind the Moon.
D. the Moon does not rotate.
E. the Moon's axis always point's toward the Earth.

122. The conditions for a solar eclipse are
A. first quarter Moon; Moon near ecliptic.
B. full Moon; Moon near ecliptic.
C. Moon at new phase; Moon near ecliptic

123. Eclipses do not occur every month because the
A. Earth's shadow varies in size.
B. Sun's angular size is slightly larger than the moons.
C. Moon's shadow varies in size.
D. Moon's orbit is inclined to the ecliptic.

124. A planet will most likely keep its atmosphere if it is
A. cold and has a strong gravitational field.
B. cold and has a weak gravitational field.
C. hot and has a weak gravitational field.
D. hot and has a strong gravitational field.
E. None of the other answers is correct.

125. The greatest difference between the atmospheres of the Jovian and terrestrial planets is that Jovian atmospheres contain much more
A. hydrogen
B. water vapor
C. carbon dioxide
D. oxygen
E. nitrogen

126. If the Earth had no oceans, today the Earth's atmosphere would be mainly
A. methane
B. carbon dioxide
C. oxygen
D. nitrogen
E. ammonia

127. Both Mars and Venus have atmospheres composed mainly of carbon dioxide.
A. True
B. False

128. The reason there are so few meteor craters now on Earth as compared to the Moon and Mars is
A. erosion occurs more rapidly on the Earth.
B. the Earth is so far away from the asteroid belt.
C. very few meteorites ever struck the Earth.
D. the Earth moves too fast in its orbit to be hit.
E. magnetic fields deflect meteoroids.

129. Regarding the origin of the Moon we think that it
A. is not fully understood.
B. was formed relatively recently, compared to Earth.
C. was pulled out of the Earth.
D. was captured as it passed near the Earth.
E. condensed out of material near the Earth.
F. collisional fragmentation theory

130. The planet whose surface looks most like the Moon is
A. Mars
B. Mercury
C. Venus
D. Earth
E. No planet looks even remotely like the Moon.

131. The pressure of the atmosphere at the surface of Venus is believed to be
A. about 100 Earth atmospheres.
B. about 10000 Earth atmospheres.
C. about the same as that of Earth.
D. about 1/100 of the pressure of the Earth's atmosphere.
E. about the same of that of Mars.

132. The observation that the surface of Venus is a lot hotter than the Earth's can be explained
A. simply by the fact that Venus is closer to the Sun.
B. by the fact that Venus has no Moon to draw off heat.
C. mostly by the greenhouse effect of Venus' atmosphere.
D. by the fact that Venus rotates very slowly.

133. The locations of mountains and valleys on Venus are best found by
A. X-rays emitted by the surface.
B. landing vehicles on the surface to drive around.
C. the strength of radio waves given off.
D. simple photographs from orbit around Venus.
E. radar measurements.

134. The surface of Venus has not been seen with telescopes on the Earth due to
A. clouds on Venus.
B. the glare of the nearby Sun.
C. the great distance between the Earth and Venus.
D. interplanetary dust.

135. In general, the younger a region on the Moon, the
A. farther it is from Earth.
B. farther it is from the center of the Moon.
C. fewer craters it has.
D. more craters it has.
E. fewer cracks or rills it has.

136. The most severe dust storms in the solar system occur on
A. Jupiter
B. Venus
C. Mars
D. Earth

137. The Viking landers showed that
A. there is most likely no life on Mars.
B. the atmosphere of Mars is mostly nitrogen.
C. there are frequent ground quakes on Mars.
D. Mars has super lightening bolts.

138. The largest valley known in the solar system was discovered by Mariner 9 on
A. a satellite of Jupiter.
B. a satellite of Saturn.
C. Venus
D. Mars
E. Mercury

139. At the north pole of Mars, the polar cap that lasts all summer is composed primarily of
A. frozen carbon dioxide
B. a mixture of liquid and frozen water (slush)
C. water ice
D. frozen nitrogen
E. fine particles of sand

140. On which planet have features been photographed that look like erosion patterns from flowing water?
A. Uranus
B. Venus
C. Jupiter
D. Mercury
E. Mars

141. The largest volcano in the solar system is found on
A. Mars
B. Phobos
C. Venus
D. Mercury
E. Earth

142. The Great Red Spot on Jupiter apparently is
A. an illusion caused by its atmosphere's lens effect.
B. a result of a Moon pulling on the magnetic field.
C. an updraft produced by winds hitting mountains.
D. a long-lasting cyclonic system in the clouds.
E. a hot area produced by falling matter from space.

143. The atmosphere of Jupiter
A. is thin and of low average density.
B. certainly contains hydrogen, helium, methane, ammonia.
C. is similar in composition to the Earth's atmosphere.
D. is very hot.
E. contains much water in the vapor state.

144. Io, the inner Galilean satellite of Jupiter, is apparently heated as a result of
A. friction by tides caused by Jupiter.
B. a slow compression of the satellite.
C. impacts of objects hitting its surface.
D. decay of radioactive elements.
E. friction with Jupiter's outer atmosphere.

145. The object with the greatest number of active volcanoes in the solar system is
A. Io
B. Miranda
C. Venus
D. Earth
E. Mars

146. Compared to the inner Galilean satellites of Jupiter, the outer Galilean satellites
A. have fewer craters.
B. contain more water ice.
C. are considerably richer in iron.
D. travel faster in their orbits.

147. The interior of Jupiter pricipally consists of
A. gaseous hydrogen and an icy/rocky core.
B. gaseous hydrogen, rock and an iron core.
C. gaseous and liquid hydrogen and an ice-rock core.
D. methane, ammonia and hydrogen.
E. hydrogen and helium in gaseous form.

148. Saturn's rings are believed to be composed of
A. frozen hydrogen.
B. a liquid disk.
C. a solid disk of frozen methane.
D. long strands of complex organic molecules.
E. small bodies of rock and ice.

149. Saturn's Moon Titan is unusual in that it
A. has an extensive atmosphere.
B. is cold.
C. has active volcanoes.
D. is much larger than any other satellite.
E. has dry ice (frozen carbon dioxide) clouds.

150. On the basis of unexplained deviations in the orbit of Uranus, Adams and Leverrier independently predicted the existence of
A. Uranus
B. Neptune
C. Mars
D. Pluto
E. Saturn

151. The larges,most massive planet in the solar system is
A. Jupiter
B. Mars
C. Uranus
D. Saturn
E. Neptune

152. To the best of our present knowledge, Pluto is most similar to
A. the Jovian planets.
B. the terrestrial planets.
C. typical satellites of Jovian planets such as Ganymede.
D. Io.
E. the Earth's Moon.

153. The planet discovered in 1930 by Clyde Tombaugh at the Lowell Observatory in Flagstaff, Arizona is
A. Neptune
B. Callisto
C. Uranus
D. Mercury
E. Pluto

154. The presence of a planet or planets between the orbits of Mars and Jupiter is predicted by
A. Kepler's harmonic law
B. Newton's law of gravitation
C. Bode's law
D. Newton's first law of motion
E. All of the other answers.

155. The planets for which the relationship given by Bode's law fails to give the approximate orbit size are
A. Uranus and Pluto
B. Pluto and Neptune
C. Mars and Neptune
D. Jupiter and Neptune

156. The discovery of asteroids depends on the fact that, compared to the background stars, asteroids
A. vary in brightness.
B. look brighter.
C. move.
D. look bigger.

157. The largest asteroid (minor planet) has a diameter of
A. 1 kilometer - .6 miles
B. 1000 kilometers - 600 miles
C. 100 kilometers - 60 miles
D. 300 kilometers - 180 miles
E. 20 kilometers - 12 miles

158. The diameters of most observed asteroids are
A. several hundred miles.
B. a mile or so.
C. 50-100 miles.
D. over 1000 miles.
E. 100-500 miles.

159. The difference between an asteroid and a comet is that
A. asteroids get closer to the Sun than comets do.
B. asteroids get farther from the Sun than comets do.
C. asteroids are smaller than the solid part of comets.
D. asteroids are larger than the solid part of comets.
E. no ices are on or near the asteroids' surface.

160. Ceres, although originally believed to be a major planet, actually belongs to the group of objects called:
A. asteroids
B. meteorites
C. comets
D. meteoroids

161. An asteroid or minor planet consists mostly of
A. hydrogen and helium
B. dust
C. ice
D. rock
E. frozen gases

162. Halley's Comet had been observed several times before Halley was born.
A. True
B. False

163. The period of Halley's Comet is (in years) about
A. 145
B. 35
C. 76
D. 245
E. 93

164. Halley's Comet returns to the Sun about once every 76 years. Therefore, its greatest distance from the Sun is closest to the distance from the Sun of
A. Earth
B. Mercury
C. Mars
D. Pluto
E. Venus

165. One surprise from close-up observations of Halley's comet was that the nucleus
A. was nearly spherical
B. appeared to consist of only one piece
C. was covered with craters
D. was so dark
E. was so small

166. If the distance from the Earth to the Sun is 1, then comets making their first pass near the Sun arrive from a distance of about
A. 100,000
B. 1,000,000
C. 100
D. 10,000
E. 1,000

167. Kepler's laws of motion imply that comets with highly elliptical orbits will
A. spend most of their time near the Sun.
B. spend most of their time at great distances from the Sun.
C. travel with a uniform velocity.
D. be confined to the plane of the ecliptic.

168. Short-period comets
A. are larger than long-period comets.
B. are a result of Jupiter's gravitational field.
C. have only one tail.
D. spend all their time in the Oort cloud.

169. The tail of a comet generally
A. follows the comet.
B. points away from the Sun.
C. precedes the comet.
D. points toward the Sun.
E. points toward the Earth.

170. What forces a comet's tail away from the head?
A. Heavier particles naturally go slower.
B. Lighter particles naturally go slower.
C. Gravitational pull from the Sun and planets.
D. The tail has a larger orbit around the Sun.
E. Both radiation pressure and solar wind.

171. If a comet is observed to have two tails, one rather featureless and the other showing much structure, we are probably seeing a seperation of the dust from the gas given off by the comet.
A. False
B. True

172. A "new" comet, making its first pass by the Sun, approaches the Sun on an orbit which is
A. somewhat eccentric, reaching the orbit of Neptune.
B. usually in the plane of the ecliptic.
C. about as circular as an asteroid's orbit.
D. a spiral, continually circling and approaching the Sun.
E. very eccentric, reaching the limit of the solar system.

173. The nucleus of a comet is about _____ in radius.
A. 160 km - 100 miles
B. 1600 km - 1000 miles
C. 16 km - 10 miles

174. Which of the following is a snowball roughly ten miles across?
A. supernova
B. comet
C. meteor shower
D. planet

175. A vast cloud or reservoir of comets has been proposed by J.H. Oort to be revolving around the Sun in a region
A. 50,000 to 150,000 A.U. from the Sun.
B. occupied by the nearest stars.
C. 50 to 100 A.U. from the Sun.
D. just outside the orbit of Pluto.

176. Which of the following occurs in the Earth's atmosphere?
A. lunar eclipses
B. supernova
C. meteor shower
D. comet

177. Meteors are usually best observed between
A. noon and sunset.
B. sunrise and noon.
C. sunset and midnight.
D. midnight and sunrise.

178. Which of the following is only visible for a few seconds?
A. lunar eclipse
B. comets
C. meteor

179. A fireball is
A. a large bright meteorite.
B. a large bright meteor.
C. a more common name for the head of a comet.
D. another name for ball lightning.

180. The Perseid meteor shower results from
A. carbon dioxide
B. comet debris
C. small minor planets
D. fireballs
E. solar wind

181. If you were an astronaut on the dark side of the Moon and your task was to count meteors, how many would you expect to see in one hour?
A. about 100
B. many more than on Earth
C. none
D. about the same as on Earth
E. about a dozen

182. Which type of meteorite is most common to see in museums and why?
A. stony; most meteorites hitting Earth are stony.
B. iron; most meteorites hitting Earth are iron.
C. iron; they look unusual and don't crumble.
D. stony; they look unusual hitting Earth.
E. stony; they have an unusual low density for stones.

183. A meteor radiant is the
A. luminous trail of a bolide.
B. point in the sky from which a meteorite is seen to fall.
C. brightest meteor of a shower of meteors.
D. point in the sky from which shower meteor trails diverge.
E. radiation we receive from meteors.

184. The meteoroid which gives rise to an average naked-eye meteor is about the size of
A. an atom.
B. this classroom.
C. a bowling ball.
D. a grain of sand.

185. The Barringer meteor crater is a mile wide. The asteroid which made it was roughly _____ wide.
A. 0.1 inch
B. 10 yards
C. 10 miles
D. 1 millionth of an inch
E. 1 mile

186. What effect of a meteor impact may have killed the dinosaurs?
A. shock wave
B. being hit by small fragments
C. dust blocking sunlight
D. increased ocean tides
E. a change in the Earth's orbit.

187. Most meteorites come from
A. comets
B. material ejected from the Moon.
C. asteroids
D. outside our solar system.
E. None of the other answers listed here is correct.

188. Meteorites are best seen
A. shortly before sunrise.
B. in museums.
C. in November.
D. shortly after sundown.

189. Which continent has been the best place to find meteorites?
A. North America
B. Africa
C. Asia
D. South America
E. Antarctica

190. Which of the following is now visible as a well-formed crater?
A. Tunguska event
B. Barringer meteor crater
C. Serpent Mound, Ohio
D. Sudbury igneous complex

191. A faint glow, concentrated along the ecliptic and sometimes seen in the west as darkness falls or in the east just before it gets light, is known as the
A. ecliptic light
B. Milky Way
C. Zodiacal light
D. ecliptic glow
E. asteroidal glow

192. Which of the following lists orders the regions of the electromagnetic spectrum from shortest wavelength to longest wavelength?
A. infrared, visible, radio, ultraviolet, x-ray, gamma-ray
B. gamma-ray, x-ray, radio, ultraviolet, visible, infrared
C. radio, infrared, visible, ultraviolet, x-ray, gamma-ray
D. gamma-ray, x-ray, ultraviolet, visible, infrared, radio

193. The wavelength of red light is
A. of a higher frequency than that of blue light.
B. longer than the wavelength of blue light.
C. stronger than white light.
D. shorter than the wavelength of blue light.

194. The various wavelengths of radiant energy travel in a vacuum at a speed which
A. equals approximately 300,000 kilometers per second.
B. is greater, the shorter the wavelength.
C. varies inversely as the square of the distance.
D. is smaller, the shorter the wavelength.

195. If a radar astronomer sends a radio pulse toward the sun, before being able to observe the reflected pulse coming back from the sun, he would just have time to
A. blink his eyes.
B. serve a term as a U.S. senator.
C. read Tolstoy's "War and Peace".
D. have a cup of coffe and a doughnut.

196. Since blue photons have more energy than red photons, they travel faster through space.
A. False
B. True

197. Roemer was able to estimate the velocity of light by
A. using two mirrors.
B. timing the velocity in water.
C. observing the Earth's rotation.
D. measuring the distance to the Sun.
E. observing Jupiter's satellites.

198. The speed of light in a vacuum is
A. 30,000,000,000 km/sec
B. 18,600,000,000 cm/sec
C. 18,600,000,000 km/sec
D. 0.00003 km/sec
E. 300,000 km/sec

199. A photon moves with a speed of roughly
A. 193 mi/sec
B. 186,000 mi/sec
C. 681,000 mi/sec
D. 86,000 mi/sec
E. 1.93 billion mi/sec

200. Letting light pass through two or more closely-spaced slits is important because it demonstrates that waves from each slit
A. produce the photoelectric effect.
B. interfere with waves from other slits.
C. can produce absorption lines.
D. cause atoms to absorb the light.
E. travel at the same speed as waves from other slits.

201. When comparing water waves and light waves, we find that
A. only water waves interfere with each other.
B. only light waves display Doppler shifts.
C. only light waves can reflect off barriers.
D. only light waves interfere with each other.
E. both spread out after passing through a narrow opening.

202. The fact that light shows Doppler shifts indicates that
A. light can behave like particles.
B. red photons have less energy than blue photons.
C. the speed of light in a vacuum is a constant.
D. the energy of a photon depends on its frequency.
E. light can behave like waves.

203. The wave nature of light is demonstrated by
A. the fact light can have different colors.
B. spectral lines.
C. the photoelectric effect.
D. reflection of light.
E. diffraction and interference of light.

204. The bending of light on passing from a medium of low density to one of a higher density is called
A. reflection.
B. refraction.
C. infraction.
D. diffraction.
E. dissection.

205. Upon passing through a prisim, blue light is refracted (bent) more than red light because in the prisim
A. red light has a longer wavelength than blue light.
B. blue light has greater energy than red light.
C. blue light is slowed more than red light.
D. red light is slowed more than blue light.

206. A simple convex lens forms the image of a distant point source at a place called the
A. focal length
B. objective
C. object point
D. focal point

207. If a lens is used to collect starlight and form an image of the star, the distance from the lens to the image is called the
A. light-gathering power
B. magnigying power
C. aperture
D. resolving power
E. focal length

208. Which combination of lens parameters will give the brightest image of a faint comet?
A. large diameter, short focal length
B. small diameter, short focal length
C. large diameter, long focal length
D. small diameter, long focal length

209. The primary purpose of a telescope is
A. to keep astronomers off the streets at night.
B. to collect and focus light.
C. to break light into its component wavelengths.
D. to magnify.

210. For a given wavelength of light, the thoretical resolving power of a telescope depends on the
A. distance to the object under observation.
B. diameter of the objective.
C. brightness of the object under observation.
D. magnification of the telescope.
E. focal length of the objective.

211. The bigger the primary lens or mirror in a telescope,
A. the redder objects seen through it appear.
B. the more light the telescope collects.
C. the farther away objects seen through it would appear.
D. the bigger the area of the sky one can see at one time.
E. None of the other answers is correct.

212. The objectives of the largest refracting telescopes cannot be as large as those of the largest reflecting telescope because
A. light refracts differently in a very large lens.
B. a very large lens would sag under its own weight.
C. the telescope tube would bend under the lens' weight.
D. we cannot make a large enough piece of clear glass.
E. different colors come to a focus at different places.

213. Spherical mirrors are not normally used in a telescope due to the fact
A. they cause spherical aberration.
B. they cause chromatic aberration.
C. they cause coma.
D. they are hard to make.

214. The world's largest refracting telescope is located at which observatory?
A. Cerro Tololo
B. Lick
C. Yerkes
D. Kitt Peak
E. Palomar

215. The largest fully operating optical telescope in the U.S. is the _____ telescope.
A. Lick
B. Yerkes
C. Keck
D. Palomar
E. Lowell

216. When looking at Mars through a telescope, one sees the image shimmering as a result of
A. turbulence in the Earth's atmosphere.
B. defects in the eyepiece lens.
C. dust storms on Mars.
D. convection currents in the atmosphere of Mars.
E. Martians.

217. Observatories are built at high altitudes to
A. reduce the effects of ozone.
B. reduce the effects of precession.
C. minimize atmospheric effects.
D. get closer to the stars.

218. The most important reason for placing telescopes in orbit around the Earth is to
A. detect wavelengths that don't penetrate our atmosphere.
B. avoid rotating telescopes to follow stars across the sky.
C. avoid problems of light emitted by our atmosphere.
D. observe during the daytime.
E. avoid interference of clouds.

219. Ceres, the largest asteroid, has a diameter of about
A. 1 kilometer - .6 miles
B. 100 kilometers - 60 miles
C. 20 kilometers - 12 miles
D. 300 kilometers - 180 miles
E. 1000 kilometers - 600 miles

220. One theory for the extinction of the dinosaurs is
A. a plague.
B. the collision of the Earth and a large meteoroid.
C. tidal heating due to the Moon.
D. changing climate due to a hotter Sun.

221. Most meteors are caused by material from
A. Jupiter.
B. asteroids.
C. Earth's Moon.
D. large moons of Jupiter.
E. comets.

222. Solid particles orbiting around the Sun can sometimes be seen as the
A. ecliptic light.
B. equinoxial light.
C. Aurora Borealis.
D. cometary glow.
E. zodiacal light.

223. Which of the following killed over 15,000 reindeer, and produced a shock measured around the world?
A. Sudbury igneous complex.
B. meteor of 63 million years ago.
C. Barringer meteor crater.
D. Tunguska event in Siberia in 1908.

224. Periodic meteor showers are probably caused through interaction of the Earth's atmosphere and debris from
A. comets.
B. asteroids.
C. the Sun.
D. meteorite.
E. Saturn's rings.

225. An exceptionally bright meteor, which can attract much attention, is called
A. a fireball.
B. a meteoroid.
C. a sporad.
D. an omen.
E. a comet.

226. The largest number of meteors are seen
A. after midnight.
B. at midnight.
C. before midnight.

227. Comets making their first pass close to the Sun have come directly from
A. the region between Uranus and Neptune.
B. the Oort comet cloud, roughly 100,000 AU away.
C. orbits between Mars and Jupiter.
D. other stars.
E. Jupiter.

228. The best current models for a comet consider them to be made mostly of
A. dirt mixed with snow and ice.
B. loose, sandy grains.
C. rock.
D. pure hydrogen.

229. If a comet has two tails, one rather featureless and the other showing much structure,
A. both would probably have bright spectral lines.
B. one would probably be dust and the other gas.
C. both tails must follow the comet through space.
D. both would probably have dark spectral lines.
E. only one tail would follow the comet through space.

230. Jupiter's family of comets is a group of comets which
A. were predicted by Swift in "Gulliver's Travels".
B. contains three sets of twins.
C. have orbits comparable in size to planet's orbits.
D. revolve around Jupiter.
E. have unusually long and prominent tails.

231. The quickest way to tell which way a comet is moving in space is to remember the tail always follows the head.
A. False
B. True

232. Close-up photographs of the nucleus of Halley's comet show it to
A. be considerably smaller than expected.
B. have a surface composed of water ice.
C. be the darkest material yet discovered.
D. be shaped like a disk.
E. rotate very slowly, slower than Mercury.

233. The objects composed mostly of rock are the
A. Jovian planets.
B. comets.
C. iron meteorites.
D. asteroids.

234. The largest asteroid
A. is about 1,000 km (600 miles) in diameter.
B. was discovered in 1961.
C. is not much larger than a city block in size.
D. is equal in size to one of the Galilean satellites.
E. is in orbit about Jupiter.

235. Bodes Law doesn't work for
A. Uranus and Pluto.
B. Jupiter and Neptune.
C. Pluto and Neptune.
D. Mars and Neptune.
E. the Asteroids.

236. The asteroids mostly lie between Mars and
A. Mercury
B. Uranus
C. Jupiter
D. Earth
E. Pluto

237. The rotation period of and asteroid is usually found from
A. variations in its reflected light.
B. Doppler shifts in its radar waves.
C. Doppler shifts in its spectral lines.
D. the strength of its infrared emission.
E. photographs taken by spacecraft.

238. Halley was the first to see Halley's comet.
A. False
B. True

239. Halley's Comet returns to the Sun about once every
A. 35 years
B. 256 years
C. 76 years
D. 93 years
E. 159 years

240. Halley's Comet takes 76 years to orbit the Sun and Uranus takes 84 years. From this information we can calculate that, compared to the orbit of Uranus, Halley's comet has an orbit
A. which stays close to the Sun.
B. with a faster average speed.
C. with a larger semi-major axis.
D. of about the same shape.
E. with slightly smaller semi-major axis.

241. The distance between the image that a distant object forms and the lens (mirror) of a telescope is the _____ of the lens.
A. focal length
B. secondary
C. objective
D. refractor
E. magnifying power

242. An advantage of a large reflecting telescope over a refractor of the same size is that the objective of a reflector
A. does not make the image appear upside down.
B. has considerably more light-gathering power.
C. has a greater magnifying power.
D. can be mechanically supported across its back surface.
E. has better resolving power.

243. The main reason for using a parabolic mirror in a telescope instead of a spherical one is
A. they reflect more light.
B. spherical aberration can be avoided.
C. they are cheaper.
D. coma can be avoided.

244. Twinkling of starlight is caused by
A. turbulance in the Earth's atmosphere.
B. signals from intelligent beings on other planets.
C. clouds in the ionosphere.
D. the solar wind.

245. Telescopes are often placed on mountain tops so that the telescope will
A. look through less of the Earth's atmosphere.
B. be less affected by low temperatures.
C. weigh less, being farther from the center of the Earth.
D. be less affected by high winds.
E. be able to detect x-rays from space.

246. The world's largest telescope with a lens for an objective is located at which observatory?
A. Cerro Tololo
B. Yerkes
C. Kitt Peak
D. Palomar
E. Lick

247. The largest telescopes used for observation in the visible (optical) region of the spectrum
A. are reflecting telescopes.
B. suffer from chromatic aberration.
C. are refracting telescopes.
D. are radio telescopes.

248. To find the total mass of a visual binary, we need to first find its
A. space velocity and apparent orbit.
B. true orbit and proper motion.
C. Doppler shift and proper motion.
D. apparent magnitude and distance from Earth.
E. distance from Earth and the apparent orbit.

249. The primary reason for making telescopes very large is
A. to gather as much light as possible.
B. to make sharp images.
C. to reduce the seeing effects of the atmosphere.
D. show colors correctly.
E. to magnify greatly.

250. The color of light depends on its wavelength.
A. True
B. False

251. Which of the following lists orders the regions of the electromagnetic spectrum from longest wavelength to shortest wavelength?
A. radio, infrared, visible, ultraviolet, x-ray, gamma-ray.
B. gamma-ray, x-ray, ultraviolet, visible, infrared, radio.
C. gamma-ray, x-ray, radio, ultraviolet, visible, infrared.
D. x-ray, radio, infrared, visible, ultraviolet, gamma-ray.
E. infrared, visible, radio, ultraviolet, x-ray, gamma-ray.

252. Roemer was able to estimate the velocity of light by
A. timing eclipses of the Moon.
B. timing eclipses of Jupiter's satellites.
C. timing eclipses of the Sun.

253. The speed of light in a vacuum is
A. 18,600,000 miles/sec =3D 30,000,000 km/sec.
B. 30,000 km/sec =3D 18,600 miles/sec.
C. 18,600,000,000 miles/sec =3D 30,000,000,000 km/sec.
D. 300,000 km/sec =3D 186,000 miles/sec.

254. It takes light roughly _____ to go from the Sun to the Earth.
A. 2 hours
B. 30 seconds
C. 8 minutes
D. 1 second
E. 1 year

255. The Doppler Effect predicts that the wavelength of light from a source moving towards you will be ____ and the frequency will be _____.
A. increased; increased
B. decreased; increased
C. decreased; decreased
D. increased; decreased

256. When a wave passes through a narrow opening, the wave subsequently spreads out. This is called
A. reflection.
B. dispersion.
C. interference.
D. diffraction.
E. refraction.

257. The phenomenon of refraction is the ____ of a light beam as it passes slantwise from a medium of one density into a medium of another density.
A. weakening
B. bending
C. dispersion
D. reflecting

258. Upon passing through a lens blue light is refracted (bent) more than red light because in the lens
A. red light is slowed more than blue light.
B. blue light is slowed more than red light.
C. blue light has greater energy than red light.
D. red light has a longer wavelength than blue light.

259. The higher the frequency of light
A. the greater its velocity in a vacuum.
B. the longer its wavelength.
C. the redder it will be.
D. the shorter its wavelength.

260. A meteor shower is named after the constellation containing its
A. radiant.
B. asteroid.
C. comet.
D. nickel-iron.
E. plumbing.

261. The meteoroid which gives rise to an average naked-eye meteor is about the size of
A. a molecule.
B. Shaquille O'Neal
C. a grain of salt.
D. a basketball.

262. One advantage of a reflecting telescope compared to a refracting telescope is that the reflecting telescope
A. can see the far side of the Moon in daytime.
B. more easily focuses all wavelengths at the same place.
C. can be used only at prime focus.
D. doesn't need cleaning as often.

263. The best place to put a ground-based observatory is on a mountain in a location where the climate is
A. cold
B. wet
C. dry
D. toxic
E. hot

264. Isaac Newton discovered that sunlight
A. causes interference.
B. behaves like waves.
C. is only a dream at MSU.
D. is made up of all the colors of the rainbow.
E. causes skin cancer.

265. Isaac Newton showed that light of a particular color
A. does not show refraction properties.
B. does not behave like a wave.
C. does not have the ability to refract.
D. cannot be seperated into components of other colors.
E. is prettier than light of another color.

266. Isaac Newton invented
A. the reflecting telescope.
B. fig-filled cookies.
C. the prism.
D. the refracting telescope.

267. The electrical charges on the proton and electron are
A. of unequal strength but same sign.
B. of equal strength but opposite sign.
C. both positive.
D. respectively, negative and positive.

268. Atoms are classified as different elements according to the number of
A. neutrons in the nucleus.
B. protons in the nucleus.
C. electrons in the nucleus.
D. protons and neutrons in the nucleus.
E. electrons surrounding the nucleus.

269. Molecules are formed when two or more atoms
A. share electrons.
B. share nuclei.
C. exchange nuclei.

270. Hydrogen, the simplest of the chemical elements, consists of
A. a single electron revolving around a single electron.
B. a single proton revolving around a single electron.
C. a single electron revolving around a single neutron.
D. a single electron revolving around a single proton.
E. None of the other answers.

271. The particles found in the nucleus of an atom are
A. electrons and protons.
B. electrons and neutrons.
C. electrons, neutrons and protons.
D. protons and neutrons.

272. A certain amount of energy is added to an atom to lift an electron from one orbit to another. If the electron then goes back to the initial orbit,
A. a smaller amount of energy is released.
B. the same amount of energy must be added again.
C. a greater amount of energy must be added again.
D. a larger amount of energy is released.
E. the same amount of energy is released.

273. Which force holds people together?
A. strong nuclear
B. gravity
C. weak nuclear
D. electromagnetic

274. An atom can absorb light if the energy of the light
A. is less than that of a proton.
B. moves an electron to a lower orbit.
C. equals the energy difference between electron orbits.
D. is less than that of an electron.
E. exceeds the energy difference between electron orbits.

275. When an electron jumps spontaneously from an outer orbit to an inner orbit,
A. a photon is emitted.
B. the electron gains energy.
C. the atom is said to be ionized.
D. the electron changes its atomic number.
E. a photon is absorbed.

276. If you made a movie of an atom absorbing light, and played the movie backwards, it would show an atom
A. absorbing light.
B. being ionized.
C. recombining.
D. emitting light.
E. violating the laws of physics.

277. When an atom emits a photon in a given spectral line, the energy of the photon is determined by
A. the distance from the atom to the observer.
B. whether the electrons move to a smaller or larger orbit.
C. the temperature of the atom.
D. the speed of the atom across the line of sight.
E. the energy lost by the electron changing orbits.

278. The larger the energy difference between two atomic orbits of an electron, the
A. more the atom becomes an isotope.
B. greater the change in the charge of the atom.
C. greater the wavelength of the emitted light.
D. shorter the wavelength of the emitted light.

279. The positions of the spectrum lines emitted by an element are primarily influences by
A. the number of neutrons in the nucleus.
B. the number of electrons orbiting the atom.
C. the number of isotopes present.
D. the mass of the nucleus.

280. Compared to spectral lines of helium gas, the spectral lines of hydrogen gas
A. are more likely to be absorption lines.
B. have completely different wavelengths.
C. are more likely to be emission lines.
D. are shifted to shorter wavelengths.
E. appear fainter.

281. If an electron is completely detached from an atom
A. the atom is at absolute zero.
B. the atom is an isotope.
C. the atom is ionized.
D. the atom is in its ground state.

282. Ions are atoms with
A. fewer electrons than protons.
B. more electrons than protons.
C. a different number of electrons than protons.
D. no electrons.

283. What "shifts" when we have a Doppler shift?
A. rotation axis of a spinning body.
B. direction
C. wavelength
D. speed
E. None of the other answers is correct.

284. Radial velocity is the speed
A. of radio waves.
B. away from the center of a circle.
C. of the rim of a wheel.
D. toward or away from the observer.
E. None of the other answers are correct.

285. The spectral lines of a star are observed to be shifted toward the blue. Therefore
A. the star is rather cool.
B. the star is approaching us.
C. the star is very hot.
D. the star is receding from us.

286. A continuous spectrum is formed by
A. a glowing metal.
B. all of the other answers.
C. the tungsten filament of a light bulb.
D. the photosphere of the Sun.

287. An absorption-line spectrum is formed by
A. a glowing gas at constant temperature.
B. a glowing metal.
C. a cool gas between the observer and a hot dense body.
D. a hot gas in front of a cool dense source of radiation.
E. None of the other answers.

288. The spectrum of a cloud of glowing gas seen against a dark background would show
A. dark (absorption) lines.
B. either bright or dark lines, depending on distance.
C. bright (emission) lines.
D. a Doppler shift.
E. a continuous spectrum.

289. Temperature is related to the _____ of atoms.
A. size
B. densities
C. atomic weight
D. mass
E. speed

290. Stefans' law states that the amount of energy radiated by each square centimeter of a body is
A. proportional to its temperature.
B. proportional to the cube of the temperature.
C. proportional to the fourth power of its temperature.
D. proportional to its distance.
E. proportional to the cube of the wavelength.

291. The wavelength at which the maximum energy is radiated from a black body is
A. independent of the temperature.
B. directly proportional to the fourth power of the temperature.
C. inversely proportional to temperature.
D. directly proportional to temperature.
E. proportional to the inverse square of temperature.

292. As a glowing black body gets hotter, what happens to its color and what happens to the brightness of the red light it emits?
A. color gets more red; all colors get stronger.
B. color gets more blue; all colors don't change.
C. color gets more blue; all colors get weaker.
D. color gets more blue; all colors get stronger.
E. color gets more red; all colors get weaker.

293. The easiest way to discover the chemical composition of the Sun is to
A. send a space probe to the solar surface to take a sample.
B. measure the lines in the Sun's spectrum.
C. observe the Doppler shift by means of radar waves.
D. measure how bright the Sun appears.
E. study the formation of solar flares.

294. The luminosity of a star
A. is the rate a which it radiates energy.
B. can be measured only if the star is ten parsecs away.
C. was first introduced by Hipparchus.
D. usually is greater for stars with large proper motion.
E. depends upon the distance to the star.

295. The most important reason for measuring distances to stars is to
A. find spectral types for stars.
B. find out what direction clusters of stars are moving in.
C. see how many stars could influence the Oort comet cloud.
D. convert radial velocity to space velocity.
E. determine how luminous they are.

296. From a star's parallax and brightness, one can find the star's
A. spectral type.
B. space velocity.
C. luminosity.
D. tangential velocity.
E. proper motion.

297. If two stars have the same luminosity, the cooler star will have a
A. greater distance.
B. larger Doppler shift.
C. bluer color.
D. fainter apparent magnitude.
E. larger diameter.

298. There are three stars which are all at the same distance and are the same size. Star A is 5000 degrees, star B is 8000 degrees and star C is 10,000 degrees. Which is brightest?
A. star B
B. star A
C. They are all equally bright.
D. star C

299. The redder a star is,
A. the younger it is.
B. the lower its surface temperature.
C. the denser it is.
D. the larger it must be.
E. the smaller it must be.

300. The main reason the pattern of stellar spectral lines changes from one spectral type to the next is the
A. diameter changes.
B. temperature changes.
C. absolute magnitude changes.
D. composition changes.

301. A yellow star like the Sun has a surface temperature of (in degrees K)
A. 20,000
B. 10,000
C. 15,000
D. 3,000
E. 6,000

302. The letters classifying the spectral sequence of stars from blue to red (high temperature to low temperature) is
A. O B A F K M G.
B. M G K F A O B.
C. M K G F A B O.
D. B A F K G M O.
E. O B A F G K M.

303. Knowing only the color of a star, one can often estimate the star's
A. radial velocity
B. mass
C. luminosity
D. apparent magnitude
E. temperature

304. The most abundant chemical elements in a star's photosphere will almost always give the strongest spectral lines in the spectrum.
A. True
B. False

305. As we look at the stars hotter than spectral class A, the higher the temperature, the weaker the hydrogen spectral lines. Why?
A. All hydrogen atoms have electrons in the first orbit.
B. Very hot stars have converted hydrogen to helium.
C. Strong helium lines cover the hydrogen lines.
D. Too much of the hydrogen is ionized.
E. The hydrogen is used to form molecules.

306. The relative strengths of absorption lines in stellar spectra, considered from hot type to cool type, would show maxima in which of the following sequences?
A. hydrogen, neutral helium, ionized helium
B. metals, molecules, helium
C. neutral metals, hydrogen, helium
D. ionized helium, hydrogen, molecules

307. If a star has very weak hydrogen lines but strong lines of molecules in its spectrum, it should be a
A. have bluer color.
B. be larger.
C. have fainter absolute magnitude.
D. be farther away.
E. fairly cool star.

308. As a general rule the more complex a star's spectrum appears to be
A. the cooler it is.
B. the older it is.
C. the greater its density.
D. the hotter it is.
E. the higher its velocity.

309. If we compare the spectra of two stars of the same temperature but much different luminosities, the star with the higher luminosity is likely to have
A. more splitting of its lines by its magnetic field.
B. narrower (less fuzzy) lines.
C. spectral lines that are easier to see.
D. stronger lines from molecules.
E. lines more broadened by its rotation.

310. The nearest star other than the Sun is roughly _____ light years away.
A. 2,000,000
B. 4
C. 60
D. 100,000
E. 1

311. The change in apparent location of an object in the sky due to the Earth's revolving is known as
A. syzygy
B. precession.
C. parallax.
D. perturbation.
E. nutation.

312. The greater the distance of a star, the smaller is its
A. rotation.
B. parallax.
C. period.
D. temperature.
E. luminosity.

313. If the parallax of a certain star is measured to be 0.1 seconds of arc, its distance is
A. 10 parsecs
B. 0.1 astronomical units
C. 1 parsec
D. 0.1 parsec
E. 10 astronomical units

314. Parallax can be used to measure distances as large as _____ parsec reliably.
A. 200
B. 1
C. 60
D. 4
E. 100,000

315. The apparent change in position of the foreground star against the background stars in photographs taken at times seperated by one year would include or show only
A. secular motion
B. parallax and proper motion
C. proper motion
D. parallax

316. With knowledge of a star's brightness and luminosity, one can compute its
A. distance
B. radius
C. surface gravity
D. temperature
E. mass

317. The most simply constructed atom, consisting of a single proton plus one orbiting electron, is
A. neutral helium
B. doubly ionized helium
C. neutral hydrogen
D. ionized hydrogen

318. The factor which distinguishes one element from another is
A. the number of protons
B. the number of ions
C. the size
D. the number of neutrons

319. The neutral subatomic particle which has a mass nearly the
same as that of a proton is the
A. neutrino
B. electron
C. photon
D. neutron

320. The nucleus of atoms other than hydrogen are composed of
A. protons, neutrons and electrons
B. protons and neutrons
C. protons and neutrinos
D. protons and electrons
E. electrons and neutrons

321. What force holds an electron in orbit in the hydrogen atom?
A. The attraction of like electrical charges.
B. The attraction of opposite electrical charges.
C. The gravity of the proton.
D. A magnetic field.
E. It needs no force to stay in orbit.

322. What is necessary for the strong nuclear force to hold together two protons?
A. The protons must have a low temperature.
B. The protons must become neutrons.
C. The protons must have opposite charge.
D. The protons must be moving slowly.
E. The protons must be very close together.

323. The greatest proportion of the mass of the atom is found
A. in the neutrons.
B. in the electrons.
C. in the protons.
D. in the nucleus.

324. Atoms make spectral lines because
A. electrons have only certain allowed orbits.
B. photons have only certain allowed orbits.
C. speed of light in a vacuum is a constant.
D. light consists of waves.

325. If we compare two stars of different temperature, the hotter star A. always emits more energy from each unit area
of surface.
B. always has higher luminosity.
C. always looks brighter as seen from Earth.
D. always will be larger.

326. The difference between a normal atom and its ion is the fact that the ion
A. has more static electricity in its nucleus.
B. doesn't have the usual number of electrons for that atom.
C. is moving more slowly than a normal atom.
D. weighs more than the atom.
E. None of the other answers is correct.

327. We don't see spectral lines from an ordinary incandescent light bulb because the glowing filament
   A. would only give bright (emission) lines.
   B. has its atoms so close together their structures are distorted.
   C. is made from atoms which never give spectral lines.
   D. would only give dark (absorption) lines.
   E. None of the other answers listed here is correct.

328. A black body emits an amount of radiation from each unit area of its surface that is proportional to
   A. the fourth power of its absolute temperature.
   B. the inverse square of its absolute temperature.
   C. the cube of its temperature divided by the mass.
   D. the fourth power of the wavelength.

329. As an object gets hotter, the average wavelength of light it emits has a shorter wavelength. Why?
   A. Atoms change color when heated.
   B. More violent atomic collisions create higher energy photons.
   C. More light is given off.
   D. Shorter wavelengths have less energy.
   E. None of the other answers is correct.

330. If we compare several objects at the same temperature, all glowing because they are hot, the one that emits the most light from each unit area of surface will also
   A. appear faintest.
   B. absorb light hitting it most efficiently.
   C. appear reddest.
   D. appear bluest.

331. In the particle picture of light, light particles are called ____and have energy associated with the _____ in the wave picture.
   A. photons, wavelength
   B. photons, waveheight
   C. electrons, frequency
   D. neutrons, wavelength
   E. protons, speed

332. Matter has a dual wave/particle nature just as light does.
   A. False
   B. True

333. An electron occupies only certain orbits in an atom because of its
   A. age
   B. negative charge
   C. particle nature
   D. snobbery
   E. wave nature

334. The radii of stars other than the Sun can be measured from a study of
   A. eclipsing binary stars
   B. their velocities
   C. visual binary stars
   D. spectroscopic binary stars
   E. variable stars

335. To find the total mass of a visual binary, we need to first find its
   A. true orbit and proper motion.
   B. Doppler shift and proper motion.
   C. distance from Earth and the angular size and period of its orbit.
   D. apparent magnitude and distance from Earth.
   E. space velocity and apparent orbit.

336. In an eclipsing binary, the deeper (less bright) eclipse occurs when the _____ star is being eclipsed.
   A. more massive
   B. more luminous
   C. hotter
   D. larger
   E. smaller

337. While observing the spectrum of a distant star, an astronomer notices that every few hours each spectral line splits and becomes two. It can be concluded
   A. there are really two stars that orbit each other.
   B. the star is moving toward the Earth.
   C. the astronomer has periodic fuzzy vision.
   D. the star is pulsating in size.

338. If a stellar spectrum has strong hydrogen lines and strong molecular lines, then probably the star
   A. is hotter than the Sun, but not extremely hot.
   B. is seen behind a dust cloud.
   C. has an unusual chemical composition.
   D. is really a double star.
   E. is quite cool.

339. The first double stars were discovered by
   A. Newton
   B. Bradley
   C. Herschel
   D. Copernicus
   E. Galileo

340. The study of binary stars is important because it allows us to measure
   A. temperature of stars.
   B. absolute magnitude of stars.
   C. parallaxes and proper motions of stars.
   D. distances of stars.
   E. masses of stars.

341. In units of the Sun's diameter, stellar diameters range from about
A. 1000 to one one-hundredth
B. 100 to one-tenth
C. 10 to one-half
D. 5 to one

342. The mass-luminosity law for main sequence stars is based on accurate mass determinations for _____ stars.
A. several thousand
B. less than one hundred
C. about ten

343. The most massive stars observed are about
A. 8000 times the mass of the Sun.
B. 80 times the mass of the Sun.
C. 800 times the mass of the Sun.
D. 80,000 times the mass of the Sun.
E. 8 times the mass of the Sun.

344. The Hertzsprung-Russell diagram shows the relation between ___ of the stars.
A. luminosity and temperature
B. period and luminosity
C. distance and luminosity
D. radial velocity and spectral type

345. In an H-R diagram, one plots a star's mass against its temperature.
A. False
B. True

346. The stars in the diagonal band running from the upper left to the lower right in the H-R Diagram are known as
A. giants.
B. main sequence stars.
C. white dwarfs.
D. supergiants.
E. All of the other answers are correct.

347. The main sequence is a sequence of surface temperature. What other physical property of a star varies continuously along the main sequence?
A. mass
B. rotational velocity
C. chemical composition
D. age
E. extent of the corona

348. The most luminous stars on the main sequence are the
A. oldest.
B. least dense of all stars
C. longest lived.
D. coolest.
E. most massive.

349. By a star's position on an H-R diagram, we can determine its
A. luminosity, surface temperature, and size.
B. distance, apparent brightness, and mass.
C. age, chemical composition, and luminosity.
D. age, luminosity, and distance.
E. color, distance, and chemical composition.

350. The largest stars are found in which corner of the H-R diagram?
A. lower left
B. upper right
C. center
D. upper left
E. lower right

351. Where would you look on an H-R diagram to find a very small star with very high density?
A. below the main sequence
B. above the main sequence
C. near the center of the main sequence
D. near the upper end of the main sequence
E. near the lower end of the main sequence

352. The method of spectroscopic parallax is used to find the _____ of a star through knowledge of its _____.
A. distance; radial velocity
B. distance; parallax
C. distance; spectral type
D. mass; luminostiy

353. We can obtain the distance to a cluster of stars by comparing an H-R diagram for nearby stars with the cluster's
A. spectral type-color diagram
B. luminosity-proper motion diagram
C. color-luminosity diagram
D. proper motion-tangential velocity diagram
E. color-brightness diagram

354. The Sun is a
A. blue star
B. giant star
C. main sequence star
D. white dwarf star
E. supergiant star

355. The stars which lie closest to the Sun in space are mostly
A. larger than the Sun.
B. much more luminous than the Sun.
C. less luminous and cooler than the Sun.
D. younger than the Sun.
E. hotter than the Sun.

356. The most abundant element in the Sun is
A. helium
B. oxygen
C. hydrogen
D. carbon

357. The spectral lines of a star are observed to be shifted to longer wavelengths than those measured for a source at rest. Therefore, A. the star is moving away from us.
B. the star is approaching us.
C. the star is very hot.
D. the star is rather cool.

358. Studying the spectrum of the Sun can give no information about its
A. speed toward or away from the Earth.
B. distance.
C. chemical composition.
D. magnetic fields.
E. None of the other answers is correct.

359. Suppose a star's parallax and brightness have been measured. It is then possible to calculate
A. the density and luminosity.
B. its temperature.
C. the distance and proper motion.
D. the distance and luminosity.

360. With knowledge of a star's brightness and luminosity, one can compute its
A. distance
B. temperature
C. radius
D. larger Doppler shift
E. cooler surface temperature

361. We see absorption lines from different atomic elements in the spectra of stars with different surface temperatures because
A. composition of stellar surfaces depends on = temperature.
B. potential energy is converted to kinetic energy.
C. excitation and ionization depends on temperature.
D. a star's color depends on temperature.

362. The basic cause of the different spectral classes is
A. luminosity
B. surface temperature
C. composition
D. pressure
E. age

363. The letters classifying the spectral sequence of stars from blue to red (low temperature to high temperature) is
A. B A F K G M O
B. O B A F K M G
C. M K G F A B O
D. M G K F A O B
E. O B A F G K M

364. The luminosity of a star
A. is how bright it appears in the sky.
B. is greater for stars near the solar apex.
C. depends on the star's parallax.
D. is the rate it radiates energy.
E. is fainter the more distant the star.

365. The relative strengths of absorption lines in stellar spectra, considered from cool type to hot (late) type, would show maxima in which of the following sequences?
A. metals, molecules, helium.
B. neutral metals, hydrogen, helium.
C. hydrogen, neutral helium, ionized helium.
D. molecules, hydroge, ionized helium.
E. ionized helium, hydrogen, molecules.

366. If one star has strong lines of molecules and the second star has no molecular lines but strong hydrogen lines, then the first star must
A. be cooler.
B. be larger.
C. have a fainter absolute magnitude.
D. be farther away.
E. have a bluer color.

367. As a general rule the more complex a star's spectrum appears to be
A. the greater its density.
B. the cooler it is.
C. the higher its velocity.
D. the hotter it is.
E. the older it is.

368. The nearest star other than the Sun is roughly _____ light years away.
A. 100,000
B. 4
C. 2,000,000
D. 1
E. 60

369. Compared to a giant star of the same spectral class, a main sequence star will have
   A. higher luminosity.
   B. broader (or fuzzier) spectral lines.
   C. brighter apparent magnitude.
   D. cooler temperature.
   E. lower density.

370. If a star has a parallax of one-eighth of a second of arc, it is at a distance of
   A. one-eighth parsec.
   B. one-eighth light years.
   C. 206,265 astronomical units.
   D. eight light years.
   E. eight parsecs.

371. The greater the parallax of a star, the smaller its
   A. absolute magnitude
   B. temperature
   C. space velocity
   D. radial velocity
   E. distance

372. In an eclipsing binary, the deeper (less bright) eclipse always occurs when the larger star is being eclipsed.
   A. True
   B. False

373. To find the total mass of a binary star, we must know the size of the orbit which we get from the angular size of the orbit and the binary star's
   A. brightness
   B. Doppler shift
   C. proper motion
   D. distance

374. If a star's spectrum has both ionized helium lines and carbon monoxide lines, then probably the star
   A. has quite unusual chemical composition.
   B. is seen behind a dust cloud.
   C. is a binary star.
   D. is quite cool.
   E. is hotter than the Sun, but not extremely hot.

375. The type of binary star for which information about the diameters of the components is derived is a(n)
   A. eclipsing binary
   B. astrometric binary
   C. spectroscopic binary
   D. multiple star
   E. visual binary

376. If we observe a periodic change in the wavelengths in a star's spectrum, probably the star is
A. very hot.
B. among the closest stars to the Sun.
C. rotating rapidly.
D. a member of a binary system.
E. actually a planet.

377. The study of binary stars is very important in astronomy because it makes possible the most accurate determination of
A. the space motions of the stars.
B. the apparent magnitude of the stars.
C. the masses of the stars.
D. All of the other answers are correct.

378. Reliable masses have been measured for
A. most faint stars.
B. all stars which are in binary systems.
C. all of the nearer stars.
D. most bright stars.
E. only about 100 stars.

379. The most massive kind of stars known have mass in solar units of around
A. 107
B. 10
C. 80
D. 1/10
E. 1000

380. The Hertzsprung-Russell diagram shows the relation = between _____ of the stars.
A. size
B. luminosity
C. temperature and color
D. apparent brightness and diameter

381. In an H-R diagram, a star's H is plotted against its R.
A. True
B. False

382. Most of the stars on the H-R diagram belong to which group?
A. white dwarf
B. red giant
C. main sequence
D. super giants

383. In following the main sequence on the H-R diagram in the direction of increasing temperature, one is also following a sequence of
A. increasing percentage of hydrogen
B. increasing age
C. increasing mass
D. decreasing mass

384. A relationship between _____ and _____ holds for main sequence stars.
A. period, luminosity
B. temperature, period
C. mass, period
D. period, radius
E. mass, luminosity

385. Red supergiants on the H-R diagram are located
A. in the lower right hand corner.
B. on the upper right side.
C. in the middle.
D. on the far upper left side.
E. in the lower left hand corner.

386. Which of the following stars would be the largest?
A. luminosity of 1 unit, temperature of 3000 degrees
B. luminosity of 10 units, temperature of 6000 degrees
C. luminosity of 10 units, temperature of 3000 degrees
D. luminosity of .1 units, temperature of 3000 degrees
E. luminosity of 1 unit, temperature of 6000 degrees

387. Where would you look on an H-R diagram to find a star with very low average density?
A. near the upper end of the main sequence.
B. near the center of the main sequence.
C. above the main sequence.
D. below the main sequence.
E. near the lower end of the main sequence.

388. The distances of the stars can be inferred from a study of their
A. velocities in the line of sight.
B. spectrum and apparent brightness.
C. richness of spectrum.
D. apparent brightness.
E. None of the other answers is correct.

389. If a color-brightness diagram of a cluster of stars is compared to an H-R diagram of stars around us, we can use the comparison to find the cluster's
A. mass.
B. size.
C. metal content.
D. space velocity.
E. distance.

390. The Sun is an example of
A. a typical giant star.
B. on of the intrinsically bright stars.
C. a common main sequence star.
D. a rapidly evolving star.
E. a long period variable star.

391. If we take a census of the 37 nearest stars, we find that the Sun is
A. one of the least luminous.
B. one of the most luminous.
C. about average with regard to luminosity.

392. The chemical composition of the Sun, by weight, is about
A. 75 percent carbon, 25 percent helium.
B. 50 percent metals, 50 percent helium.
C. 50 percent metals, 50 percent hydrogen.
D. 73 percent hydrogen, 25 percent helium, 2 percent others.
E. 75 percent helium, 20 percent hydrogen, 5 percent others.

393. The locations of all but a few of the stars in the solar "neighborhood" on the H-R diagram are
A. in the Supergiant Region.
B. on the main sequence.
C. in the White Dwarf Region.
D. in the H-R Block.

394. Cecelia Payne-Gaposhkin studied spectra of stars of various colors and concluded not only that star spectra depended primarily on temperature but that the compositions of the stars
A. are virtually the same.
B. vary greatly with temperature.
C. cannot be measured.
D. are primarily of iron when cool and hydrogen when hot.

395. The very high pressure inside the Sun does not blow the Sun apart because of the
A. nuclear reactions going on there.
B. Sun's neutrino emission.
C. Sun's magnetic field.
D. Sun's rotation.
E. inward force of gravity.

396. The age of the Sun is about
A. five trillion years.
B. five billion years.
C. five thousand years.
D. five million years.

397. The temperature in the center of the Sun is _____ degrees K.
A. 15 billion.
B. 15 hundred.
C. 15 thousand.
D. 15.
E. 15 million.

398. The estimated age of the Sun leads one to believe that the solar energy source is
A. gravitational contraction.
B. burning of coal.
C. uranium fission.
D. hydrogen fusion.

399. Northern Lights result from
A. sunlight shining on the Earth's north polar cap.
B. charged particles from the solar wind hitting the upper atmosphere of the Earth.
C. the burning of hydrogen high in our atmosphere.
D. light from flares hitting the Earth's upper atmosphere.
E. lightning discharges high in our atmosphere.

400. The source of energy from a nuclear transformation derives from a tiny loss of mass (m) in that transformation and the conversion of that mass loss into energy (E) according to the rule _____.
("c" is the velocity of light.)
A. c equals m times E-squared
B. E equals m times c-squared
C. E equals c times m-squared
D. m equals E times c-squared

401. The following energy sources occur in the core of the Sun during its pre-main sequence, main sequence, and red giant stages respectively:
A. hydrogen fusion, helium fusion, carbon fusion.
B. hydrogen fusion, gravitational contraction, helium fusion.
C. helium fusion, hydrogen fusion, carbon fusion.
D. cosmic rays, gravitational contraction, hydrogen fusion.
E. gravitational contraction, hydrogen fusion, helium fusion.

402. Why does the conversion of helium to carbon require a higher temperature than the conversion of hydrogen to helium?
A. Helium doesn't ionize as easily as hydrogen.
B. Carbon more easily forms a black body.
C. Helium gas is less dense than hydrogen.
D. Helium gas is more dense than hydrogen.
E. The repulsion of like charges is stronger for helium.

403. Which type of light is used to observe young stars being born?
A. ultraviolet
B. gamma-ray
C. radio
D. visible
E. infrared

404. Stars are probably being born in regions rich in
A. globular clusters.
B. dust and gas.
C. heavy elements.
D. red giants.
E. planetary nebulae.

405. A protostar becomes visible due to the energy released by
A. nuclear fission only.
B. nuclear fusion only.
C. both nuclear fusion and fission.
D. gravitational contraction.
E. gravitational expansion.

406. The order of the stages of evolution a star like our Sun goes through is
A. red giant, white dwarf, main sequence, proto-star.
B. proto-star, white dwarf, main sequence, red giant.
C. red giant, main sequence, proto-star, white dwarf.
D. proto-star, red giant, main sequence, white dwarf.
E. proto-star, main sequence, red giant, white dwarf.

407. The highest mass that a star has on the main sequence is set by the point where the
A. age of the star is older than the age of the universe.
B. central temperature causes helium to form carbon.
C. radiation is so strong it converts helium to hydrogen.
D. central temperature barely can cause hydrogen to fuse.
E. luminosity prevents more mass from collecting.

408. The lower end of the main sequence is set by the point where
A. a star's core can just barely have hydrogen fusion.
B. hydrogen stays in a liquid form.
C. stars are too faint for us to see.
D. gravity could make the star contract.
E. internal pressure would blow the star up.

409. The cluster turn-off point is
A. hotter for older star clusters.
B. used to find the ages of stars in a cluster.
C. located near the Milky Way in the sky.
D. located at the cluster's antapex in the sky.
E. located at the cluster's apex in the sky.

410. The most massive stars
A. live the longest.
B. have the shortest lives.
C. have fewer planets.
D. have the greatest number of planets.
E. have large proper motions.

411. Different stars appear at different places on the main sequence. What fundamental physical quantity causes these stars to be different?
A. age
B. brightness
C. mass
D. temperature at the surface
E. color

412. The characteristic which makes all main sequence stars different from all other stars is that main sequence stars
A. are the smallest stars.
B. convert hydrogen to helium at their cores.
C. occur in clusters.
D. have few spectral lines from heavy atoms.
E. are fairly young.

413. The Sun's location on an H-R diagram is not on the zero-age main sequence because the Sun has
A. converted some of the hydrogen in its core to helium.
B. too much pressure in its core to balance.
C. converted the helium in its core to carbon.
D. the same composition in the core as in the photosphere.
E. not yet reached the zero-age main sequence.

414. Unlike a main sequence star, a red giant at its center may be fusing
A. carbon into lead.
B. helium into carbon.
C. hydrogen into helium.
D. iron into uranium.
E. nothing. All fusion will have stopped.

415. The best candidates for pre-main sequence stars are the
A. red giants
B. RR Lyrae stars
C. T-Tauri stars
D. Cepheid variables
E. planetary nebulae

416. A star cluster whose H-R diagram has a main sequence which has only very cool stars must be
A. very old.
B. very young.
C. very far away.
D. in a spiral arm.

417. A star cluster whose H-R diagram has a main sequence which includes very hot stars must be
A. a globular cluster.
B. very far away.
C. very young.
D. very old.

418. A star with mass ten or twenty times the Sun's mass will probably become, after it is a red giant or supergiant, a
A. supernova.
B. T-Tauri star.
C. nova.
D. white dwarf.

419. As our galaxy ages the abundance of heavy elements in the interstellar medium will
A. decrease.
B. remain the same.
C. increase.

420. Iron, and elements heavier than iron, were produced in
A. main sequence stars.
B. supernovae.
C. black holes.
D. red giants.
E. white dwarfs.

421. Listed in the order of their increasing density we would find as follows the degenerate or collapsed configurations of material which are equivalent in mass to stars along the main sequence:
A. white dwarfs, neutron stars, black holes.
B. neutron stars, black holes, white dwarfs.
C. black holes, white dwarfs, neutron stars.
D. black holes, neutron stars, white dwarfs.

422. A neutron star is typically the size of
A. the Earth's orbit.
B. the Sun.
C. Mercury's orbit.
D. the Earth.
E. a large city.

423. A white dwarf is typically the size of
A. a large city.
B. Mercury's orbit.
C. the Sun.
D. the Earth's orbit.
E. the Earth.

424. After a supernova event, the remaining core of the star may become a
A. neutron star
B. white dwarf
C. quasar
D. planet
E. black dwarf

425. For low-mass stars like the Sun, the red giant stage is followed by
A. a planetary nebula and a white dwarf star.
B. a supernovae and a black hole.
C. a supernovae and a neutron star.
D. a planetary nebula and a neutron star.

426. Which of the following behaves most like degenerate matter?
A. carbon gas
B. solid metal
C. hydrogen gas
D. liquid water
E. ionized iron gas

427. The Chandrasekhar limit implies that stars ending up more massive than 1.25 solar masses cannot become
A. giant stars
B. white dwarfs
C. neutron stars
D. supernovae
E. black holes

428. An object whose gravitational field is so strong that light cannot escape is called a
A. black hole
B. neutron star
C. pulsar
D. black dwarf
E. dark nebulae

429. Suspected black holes are detected as _____ in a binary star system.
A. observed singularities
B. X-ray objects
C. Black holes cannot be detected by any known means.
D. dark objects
E. novae

430. Which one of the following is an example of a pulsating star?
A. supernova remnant
B. Mira variable
C. planetary nebula
D. eclipsing variable

431. The light variation of a Cepheid variable is best explained by the theory that Cepheids are
A. pulsating
B. exploding
C. binary stars
D. black holes
E. rapidly rotating

432. Miss Leavitt arrived at a period-luminosity relation for Cepheid variables from her studies of
A. binary stars
B. galaxies
C. the Magellanic Clouds
D. globular clusters

433. The period-luminosity law for Cepheid variables is useful in obtaining
A. the diameters of Cepheids
B. ages of Cepheids
C. the masses of Cepheids
D. All of these answers are correct
E. the distances of Cepheids

434. Mass flowing onto the surface of a white dwarf star can cause the star to become a
A. nova
B. red dwarf star
C. Cepheid variable star
D. black hole
E. red giant star

435. Most, and maybe all, novae apparently are
A. red giants
B. main sequence stars
C. members of close binary stars
D. rotating neutron stars
E. pulsating stars

436. Where does the Crab Nebula ultimately get the energy which is observed as radiation being emitted by the nebula?
A. from a pulsating white dwarf
B. from the original supernova explosion
C. from a slowdown in the spin of a neutron star
D. from very fast vibrations of a neutron star
E. from fusion of hydrogen to helium

437. The Crab Nebula is the result of a supernova explosion which occurred nearly 1000 years ago. At the present time the nebula
A. is still expanding from the original explosion.
B. appears to be expanding because it is getting closer.
C. is contracting as matter falls back onto the star.
D. has become static and quite featureless.

438. Each pulse we receive from a pulsar probably represents
A. one rotation of a white dwarf.
B. one orbital period of a neutron star.
C. one pulsation of a neutron star.
D. one rotation of a neutron star.
E. one pulsation of a white dwarf.

439. The heavy elements we see in the universe probably were created mainly in
A. red giant stars.
B. Bethlehem Steel.
C. supernova explosions.
D. nova explosions.
E. planetary nebulae.

440. The central stars of planetary nebulae
A. captured the matter of the nebulae.
B. are cool stars.
C. have condensed out of the material of the nebulae.
D. ejected the matter gound in the nebulae

441. A planetary nebula represents the transition between what two stages of a star?
A. red giants and white dwarf
B. proto-star and main sequence
C. proto-star and red giant
D. red giant and supernova
E. main sequence and Cepheid variable

442. The three fundamental forces are
A. gravity, nature and repulsion
B. faith, hope and charity
C. earth, wind and fire
D. gravitational, electromagnetic, and nuclear
E. electrical, magnetic and nuclear

443. Neither the energy associated with the _____ force nor with the _____ force is high enough to have sustained the Sun for the 3 billion years indicated by the _____ record.
A. electromagnetic, gravitational, phonographic
B. electromagnetic, gravitational, geological
C. nuclear, gravitational, geographical
D. electromagnetic, nuclear, geophysical

444. Even though they have average densities roughly equal to that of water, main sequence stars are gaseous because their interior temperatures are so high that they are completely ionized and the average particle size is therefore not the size of the atom, but the size of the nucleus of the atom
A. True
B. False

445. How old is the Sun?
A. 5 billion years old.
B. 5 trillion years old.
C. 5 million years old.
D. 5 thousand years old.
E. 5 hundred years old.

446. The temperature in the center of the Sun is about _____ degrees K which is hot enough for _____ to occur.
A. 15 thousand, hydrogen fusion
B. 15 million, hydrogen fusion
C. 15 billion, helium fusion
D. 15 hundred, nuclear fission
E. 15, unclear fishing

447. The "Northern Lights" are caused by
A. the solar wind.
B. nuclear fission.
C. nuclear fusion.
D. gravitational contraction.

448. The Sun does not collapse because its gravity is balanced by its
A. nuclear reaction rate.
B. neutrino emission.
C. magnetism.
D. internal pressure.

449. The equivalence between mass and energy was first stated by _____
A. Einstein
B. Newton
C. Fraunhofer
D. Capriotti
E. Kirchhoff

450. The following energy sources occur in the core of the Sun during its pre-main sequence, main sequence, and red giant stages respectively:
A. hydrogen fusion, helium fusion, carbon fusion.
B. gravitational contraction, hydrogen fusion, helium fusion.
C. helium fusion, hydrogen fusion, carbon fusion.
D. hydrogen fusion, gravitational contraction, helium fusion.
E. cosmic rays, gravitational contraction, hydrogen fusion.

451. Why does the conversion of helium to carbon require a higher temperature than the conversion of hydrogen to helium?
A. Helium nuclei have twice the charge and four times the mass of a proton.
B. Heliuum doesn't ionize as eaisly as hydrogen.
C. Helium gas is more dense than hydrogen.
D. Helium gas is less dense than hydrogen.
E. Carbon more easily forms a black body.

452. Young stars being born are best seen in the _____ part of the spectrum.
A. visible
B. radio
C. infrared
D. ultraviolet
E. gamma-ray

453. Regions rich in _____ are the birthplaces of stars.
A. red giants
B. heavy elements
C. globular clusters
D. planetary nebulae
E. dust and gas

454. A newly-formed star with the Sun's mass slowly contracts toward the main sequence, radiating at the expense of ____ until the onset of _____ stops the contraction and supports the star for its main sequence lifetime.
A. electromagnetic energy, hydrogen fusion
B. hydrogen fusion, helium fusion
C. gravitational energy, hydrogen fusion
D. gravitational energy, helium fusion

455. The order of the stages of evolution a star like our Sun goes through is
A. red giant, white dwarf, main sequence, proto-star.
B. proto-star, white dwarf, main sequence, red giant.
C. proto-star, main sequence, red giant, white dwarf.
D. red giant, main sequence, proto-star, white dwarf.
E. proto-star, red giant, main sequence, white dwarf.

456. A star 80 to 100 solar masses cannot grow larger as it forms because its high
A. radiation is so strong it converts helium to hydrogen.
B. central temperature barely can cause hydrogen to fuse.
C. luminosity prevents more material from collecting.
D. central temperature causes helium to form carbon.

457. A cluster of stars contains, O, B, and A main sequence stars but it also contains G and K stars lying above the main sequence. It can be concluded that
A. the cluster is about the age of the Sun.
B. the cluster is extremely young.
C. I have gotten some incorrect data from my observations.
D. I have found a halo population object.

458. The age of the Sun is found by comparing the Sun's
A. apparent magnitude to its absolute magnitude.
B. radius and luminosity to the calculated zero-age values.
C. zero-age and present photospheric compositions.
D. observed and theoretical neutrino emissions.
E. luminosity to the mass-luminosity relationship.

459. Those main-sequence stars which go through their evolution most rapidly are the
A. All main sequence stars evolve at the same rate.
B. stars like the Sun.
C. red stars of low mass.
D. very massive stars.

460. T Tauri stars are apparently
A. stars that have not yet quite reached the main sequence.
B. left over from a nova outburst.
C. stars that just left the main sequence.
D. faint main sequence stars.
E. found mostly in old star clusters.

461. I have the H-R diagram for 2 clusters. Cluster A has no main sequence stars hotter than BO, cluster B no main sequence stars hotter than FO. From this I can conclude that
A. cluster B is younger than cluster A.
B. there is something wrong with cluster B.
C. cluster B is more massive than cluster A.
D. cluster A is younger than cluster B.
E. cluster A is more massive than cluster B.

462. If we compare two main sequence stars of the same mass, one formed recently and the other formed 10 billion years ago,we find that the older star
A. has much stronger spectral lines of hydrogen.
B. has a much lower abundance of heavy elements.
C. has a much higher luminosity.
D. probably has much smaller space velocity.
E. is considerably larger.

463. A star with a mass of ten or twenty times the Sun's mass will probably become, after it is a red giant or supergiant, a _____ as a result of a _____ followed by an _____.
A. T-Tauri star, pulsation, explosion.
B. white dwarf, explosion, collapse.
C. supernova, collapse, explosion.
D. nova, contraction, expansion.

464. The elements more massive than iron were produced in
A. proto-stars
B. main sequence stars
C. the planets
D. supernova explosions
E. white dwarf stars

465. Which choice has the objects ranked by size, largest to smallest?
A. black hole, red giant, sun, neutron star, white dwarf
B. sun, red giant, black hole, neutron star
C. red giant, sun, white dwarf, neutron star, black hole
D. red giant, white dwarf, sun, neutron star, black hole

466. A neutron star
A. All the other answers are correct.
B. may result from a supernova explosion.
C. may be a pulsar.
D. may contain 1.8 solar masses.
E. may be 6 miles in diameter.

467. A white dwarf is typically the size of ___ and _____ in nature.
A. Mercury's orbit, liquid
B. the Earth, metallic
C. the Sun, gaseous
D. the Earth's orbit, gaseous
E. a large city, metallic

468. After a supernova event, the remaining core of the star may become a pulsar which is most probably a rotating
A. black dwarf
B. neutron star
C. planet
D. quasar
E. white dwarf

469. The Chandrasekhar limit implies that stars ending up more massive than 1.4 solar masses cannot become
A. giant stars
B. white dwarfs
C. supernovae
D. neutron stars
E. black holes

470. Black holes are
A. very cold stars.
B. always extremely massive objects.
C. places where no matter can exist.
D. places where gravity prevents light from escaping.

471. A black hole in space would most likely be detected by
A. its intense infrared emission.
B. pulses emitted by matter leaving it.
C. There is no way to detect a black hole in space.
D. a strong gravitational shift of spectral lines.
E. X-rays emitted by matter spiraling in towards the hole.

472. The second time the Sun moves into the red giant stage it will become a _____ that will eject its envelope forming a ____ and a ____.
A. eclipsing variable, black hole, Cepheid variable
B. supernova remnant, neutron star, black hole
C. planetary nebula, white dwarf, neutron star
D. Mira variable, planetary nebula, white dwarf

473. The energy emitted by a white dwarf comes from
A. core helium burning.
B. hydrogen burning.
C. contraction, releasing potential energy.
D. the heat stored in the star.

474. In 1912 Miss Leavitt discovered that the Cepheid variables in the Small Magellanic Cloud
   A. were all the same brightness.
   B. obeyed a period-luminosity relation.
   C. all had the same period.
   D. obeyed a period-mass relation.

475. Most, and maybe all, novae apparently are _____ that involve mass flowing onto the surface of a _____.
   A. members of close binary stars, white dwarf
   B. red giants, neutron star
   C. rotating neutron stars, pulsating star
   D. pulsating stars, rotating white dwarf
   E. main sequence stars, mira variable

476. Where does the Crab Nebula ultimately get the energy which is observed as radiation being emitted by the nebula?
   A. from a pulsating white dwarf
   B. from the original supernova explosion
   C. from fusion of hydrogen to helium
   D. from a slowdown in the spin of a neutron star
   E. from very fast vibrations of a neutron star

477. The Crab Nebula was caused by a
   A. nova
   B. supernova
   C. Neither of the other answers.

478. A pulsar is a
   A. rotating white dwarf
   B. an oscillating black hole
   C. black hole
   D. rotating neutron star

479. The heaviest (most complex) atomic nuclei found on Earth were made in
   A. a planetary nebula.
   B. the explosion of a supernova.
   C. the outer layers of a pulsating M star.
   D. the interior of the Sun.

480. The variability of the light from Cepheid variable star is
   A. undetectable.
   B. caused by a pulsation.
   C. non-repeating.
   D. caused by an eclipsing compainion.

481. A nova
   A. has its spectral lines Doppler shifted to the red.
   B. is the formation of a new star.
   C. can occur when material from a companion star flows onto the
   D. results in the destruction of a star.
   E. leads to the creation of a pulsar.

482. The "Kapteyn universe" was an early model for the
A. universe, similar to the "big bang" model.
B. universe, with the Sun displaced from the center.
C. universe, with the Sun at the center.
D. universe, similar to the "steady state" model.

483. The main reason Herschel thought the Milky Way galaxy was considerably smaller than it really is was because he did not include the effects of
A. H II regions.
B. bright blue stars.
C. the lack of heavy elements in nearby stars.
D. interstellar dust.
E. radio and spectral lines.

484. The center of the galaxy lies in the direction of
A. Shapley
B. the Big Dipper
C. the North Galactic Pole
D. Vega
E. Sagittarius

485. Roughly how long does it take for the Sun to go around the Galaxy one time?
A. 250 billion years
B. 250 million years
C. 100,000 years
D. 1 killion years
E. 6,000 years

486. The gas and dust in our galaxy is mainly
A. in the halo of the galaxy.
B. concentrated in the nucleus of the galaxy.
C. in the spiral arms.
D. ionized hydrogen.
E. between the spiral arms.

487. The 21 cm radio line, seen in many interstellar clouds, is produced by the spin-flip of an electron in
A. ionized hydrogen.
B. interstellar molecules.
C. neutral hydrogen.
D. neutral iron.
E. neutral helium.

488. The spiral arms of our Galaxy can be located by the use of
A. red giants.
B. double stars.
C. hydrogen 21 cm lines.
D. supernovae.
E. white dwarfs.

489. One advantage of using radio (21 cm) observations to map out the Galaxy is
A. the nucleus is too dim at optical wavelengths.
B. radio telescopes are cheaper.
C. spiral arms don't emit visible light.
D. we have more powerful radio transmitters.
E. radio waves pass through dusty regions.

490. The mass of our Galaxy is best found by measuring
A. the number of stars in the galaxy.
B. the masses of binary stars.
C. the rotation of the galaxy.
D. how much interstellar hydrogen is emitting radio waves.
E. the number of hot main sequence stars.

491. The objects found above and below the plane of our galaxy are generally
A. younger than disc objects.
B. O and B type main sequence objects.
C. older than disc objects.
D. a mixture of young and old objects.
E. younger than objects in the galactic nucleus.

492. Populations I and II can be distinguished by means of differences
in
A. chemical composition.
B. motions and positions in the galaxy.
C. position in the H-R diagram.
D. All of these answers are correct.

493. O and B associations and their H II regions are usually found in what part of the galaxy?
A. globular clusters
B. spiral arms
C. halo
D. nucleus
E. None of the other answers.

494. The age of the stars in a O association are at most about
A. 10 million years.
B. 1 billion years.
C. the age of the Sun.
D. 1 hundred years.

495. Shapley determined the direction of and the distance to the center of the galaxy by correctly assuming the frame of the galaxy is represented by the distribution of
A. Cepheid variables
B. O type stars
C. binary stars
D. globular clusters

496. The stars found in which type of star grouping are generally the oldest?
A. geriatricum organicum groups
B. globular clusters
C. O associations
D. galactic clusters

497. The globular clusters
A. are concentrated in the galactic nucleus.
B. are concentrated in spiral arms.
C. are present only in our galaxy.
D. are concentrated near the edge of the galaxy.
E. are spherically distributed about the galactic center.

498. If we located clouds of gas and dust on a chart of the sky, where are the clouds generally located?
A. Along the ecliptic.
B. In the same region where globular clusters are.
C. Scattered fairly uniformly over the whole sky.
D. In regions away from the Milky Way.
E. Along the Milky Way.

499. Comparing globular clusters to galactic clusters, which of the following is incorrect?
A. Globular clusters have the hottest main sequence stars.
B. Globular clusters have hotter and bluer bright stars.
C. There are more red stars in a globular cluster.
D. Globular clusters are more massive (have more stars).

500. Complex molecules such as alcohol are found mostly in
A. sunspots.
B. dark dust clouds.
C. emission nebulae.
D. supernovae.
E. the atmospheres of hot stars.

501. Interstellar dust
A. is completely transparent.
B. causes starlight passing through it to appear more blue.
C. causes the 21 cm radio emission.
D. causes starlight passing through it to appear more red.
E. None of the other answers is correct.

502. A good example of a dark nebula is the
A. Crab Nebula in Taurus.
B. Trapezium in Orion.
C. Ring Nebula in Lyra.
D. Veil Nebula in Cygnus.
E. Horsehead Nebula in Orion.

503. If several luminous hot stars are seen embedded in a cloud of glowing gas in the sky, we are probably seeing an area
A. where a new galaxy is forming.
B. where a supernova recently exploded.
C. where stars are dying out.
D. where several planetary nebulae are close together.
E. of recent star formation.

504. What determines whether a glowing cloud of gas and dust would appear as an emission nebula or a reflection nebula?
A. luminosity of the illuminating star(s)
B. temperature of the illuminating star(s)
C. distance of the illuminating star(s) from the cloud
D. distance of the illuminating star(s) from the Sun
E. chemical composition of the cloud

505. What color is a typical reflection nebula, and why?
A. Red; hydrogen has a strong red spectral line.
B. Red; red light reflects better of dust particles.
C. Red; it radiates like a red-hot black body.
D. Blue; blue light reflects better off dust particles.
E. Blue; the illuminating star is blue.

506. Planetary Nebulae and H II regions are each types of _____ nebulae but Planetary Nebulae represent stars near the _____ of their lives while H II regions represent stars near the _____ of their lives.
A. reflection, end, beginning
B. reflection, beginning, end
C. emission, beginning, end
D. emission, end, beginning

507. The Galaxy is at present thought to be about
A. 1,000,000 light years in diameter.
B. 100 parsecs in diameter.
C. 100 light years in diameter.
D. 100,000 light years in diameter.
E. None of the choices given here is correct.

508. The best estimate of the mass of the milky way galaxy is the equivalent of about
A. 200 billion suns.
B. 200 trillion suns.
C. 200,000 suns.
D. 200 suns.
E. 200,000,000 suns.

509. Galactic cannibalism refers to which process?
A. interstellar medium in plane devours orbiting popII star
B. galaxies devouring other galaxies to make bigger ones
C. stars devouring other stars to make bigger stars
D. protons devouring other protons to make helium

510. The three main types of galaxies are
A. small, medium and large
B. spiral, elliptical, irregular
C. spiral, globular, erratic
D. globular, irregular, open

511. Spiral galaxies comprise about _____ percent of all galaxies.
A. 3
B. 70
C. 25
D. 15
E. 50

512. The distance to nearby galaxies can be obtained from
A. Hubble's law.
B. Cepheid variables.
C. red giant stars.
D. trigonometric parallax.
E. spectroscopic parallax.

513. The galaxies near us (out to about 1 million parsecs) are called
A. the local group
B. the near ones
C. M33
D. the nearby crowd
E. None of these.

514. The Large and Small Magellanic Clouds are
A. large Milky Way star clusters.
B. huge distant galaxies.
C. small irregular galaxies that are companions of the Milky Way.
D. part of the Milky Way.
E. large nearby galaxies.

515. Distances to individual galaxies can be estimated by using
A. Cepheid variables in galaxies.
B. supernovae in galaxies.
C. all of the other answers.
D. H II regions.
E. the globular clusters in the galaxies.

516. The most massive galaxies belong to the type of galaxies known as
A. ellipticals
B. normal spirals
C. globular
D. barred spirals
E. irregular

517. The smallest galaxies are
A. barred spiral galaxies.
B. irregular galaxies.
C. colliding galaxies.
D. elliptical galaxies.
E. normal spiral galaxies.

518. Which type has no interstellar medium or young stars?
A. elliptical
B. Seyfert
C. spiral

519. The idea of using giant elliptical galaxies as a "standard candle" is important as a means of measuring what?
A. masses of clusters of galaxies
B. brightness of clusters of galaxies
C. color of clusters of galaxies
D. rotation rate of clusters of galaxies
E. distances of clusters of galaxies

520. Ring galaxies and galaxies with long "tails" are thought to
be created by
A. hot intergalactic gas.
B. two galaxies colliding.
C. rapid rotation of a spiral galaxy.
D. supernova explosion.
E. spiral arms that became unusually massive.

521. A galaxy that has no bright blue stars would be expected to have
A. relatively frequent supernova explosions.
B. little interstellar gas and dust.
C. a rapid rotation.
D. bright emission nebulae.
E. a relatively low mass.

522. Galaxies, on the average, are separated by
A. hundreds of billions of light years.
B. a few billion light years.
C. a few million light years.

523. Hubble's law states that the velocity of recesssion of a
A. galaxy is independent of its distance.
B. star is inversely proportional to its distance.
C. star is proportional to its distance.
D. galaxy is inversely proportional to its distance.
E. galaxy is proportional to its distance.

524. The redshifts in the spectra of remote galaxies are attributed to
A. recessional velocities.
B. gravitational fields.
C. galactic rotation.
D. black holes.
E. scattering by dust particles.

525. Hubble's study of the distribution of galaxies indicated that
A. few galaxies are seen near the plane of the Milky Way.
B. more galaxies are counted towards the globular clusters.
C. the galaxies are distributed uniformly in the sky.
D. tend to occur near H II regions.

526. Which is used to measure the mass of a galaxy?
A. period-luminosity relation
B. Kepler's third law
C. principle of relativity
D. inverse square law
E. total luminosity of galaxy

527. When we say that the universe is expanding, we mean that the distance between _____ is increasing.
A. clusters of galaxies
B. stars in the galaxy
C. galaxies in a cluster
D. All of the answers are correct.
E. None of the answers are correct.

528. The concept of the "Expanding Universe" is based on the interpretation of the observed red shifts of the galaxies as due to
A. Doppler effect.
B. continuous creation of matter.
C. "tired-out" light.
D. "Leaking" quanta.
E. Communist infiltration.

529. In terms of their absolute numbers in a given volume of space the most common kind of galaxies are
A. irregulars
B. dwarf ellipticals
C. spirals
D. giant ellipticals

530. The arms of spiral galaxies
A. expel population II stars into the corona.
B. trail behind the galactic rotation.
C. pull the galaxy around behind them.
D. are jet propelled.

531. The properties which collectively characterize Population I (disk population) stars are
A. higher metal abundances, younger ages, circular orbits.
B. low metal abundances, old ages, elongated orbits.
C. found only in black holes, old ages.
D. low metal abundances, young ages, no massive stars.

532. An experiment that demonstrates the particle nature of light is
A. diffraction.
B. refraction.
C. the photo-electric effect.
D. interference.

533. Light has a dual nature; sometimes behaving like waves, sometimes like particles.
A. False
B. True

534. The distances of stars more luminous and hotter than the sun are obtained for stars in clusters using
A. the "moving cluster" method.
B. the colors of stars in the cluster.
C. cluster sizes.
D. parallax.

535. The rotation curve of our galaxy indicates that objects in the galaxy orbit the galactic center primarily under the gravitational influence of:
A. neighboring galaxies.
B. the material in the spiral arms.
C. a massive dark matter halo.
D. a massive black hole at the center of the galaxy.
E. main sequence 0-type stars.

536. Herschel and later Kapteyn concluded that the Milky Way consists of a disk with the Sun near the center, based on his observations of
A. O and B stars.
B. H II regions.
C. the number of stars he saw in different directions.
D. distances and directions of globular clusters.
E. the 21-cm emission line.

537. As seen from the Earth, the nucleus of our Galaxy lies in the direction of the constellation
A. Sagittarius.
B. Taurus.
C. Orion.
D. Canis Major.

538. Stars in the neighborhood of the Sun revolve once around the center of the galaxy in about
A. 200 billion years.
B. 2 million syears.
C. 250 million years.
D. 2 billion years.

539. The nearby spiral arms can be traced out by using as "yardsticks" the
A. Cepheid variables.
B. O and B associations and their H II regions.
C. globular clusters.
D. binary stars.

540. The gas and dust in the Galaxy is strongly confined to the
A. galactic halo.
B. diffuse nebulae.
C. reflection nebulae.
D. H II regions.
E. spiral arms.

541. The general structure of spiral arms in distant parts of our galaxy can be mapped using
A. the 21-cm radiation of hydrogen.
B. visible light.
C. the 10-Mhz frequency of WWV.
D. visible light and 21-cm radiation of H I.

542. The 21-cm radiation from H I regions happens when
A. an O or B star is near the hydrogen.
B. two atoms collide.
C. the spin of the electron in a hydrogen atom flips.
D. two molecules collide.

543. To map very distant spiral arms in our galaxy, we must use 21-centimeter radiation rather than young hot stars because
A. hot stars get slightly reddened and look like cool stars.
B. radio waves penetrate dust clouds.
C. young hot stars are obscured by 21-cm radiation.
D. distant stars show large Doppler shifts.
E. radio waves penetrate interstellar gas.

544. The mass of our Galaxy can be calculated from its rotation and
A. Kepler's third or Harmonic law.
B. Kirchhoff's law.
C. Kepler's law of areas.
D. Since the Sun is not moving it can't be done.
E. Newton's first law.

545. Generally, as a star orbits in our galaxy, the closer it stays to the galactic plane the
A. younger it is.
B. less massive it is.
C. older it is.
D. less metals it has.
E. more eccentric its orbit around the galaxy.

546. Shapley estimated the distance to the center of our galaxy from the locations of
A. Cepheid variables.
B. globular clusters.
C. galactic clusters.
D. 21-centimeter radio emission from hydrogen.
E. young massive main sequence stars.

547. Some of the oldest stars known are to be found in
A. globular clusters.
B. regions containing dust and gas.
C. planetary nebulae.
D. the spiral arms of the galaxy.
E. open clusters.

548. Comparing globular clusters and open clusters, which of the following is true?
A. Globulars are found closer to the Milky Way in the sky.
B. Open clusters are more massive (have more stars).
C. There are more red stars in open clusters.
D. Stars in globulars have strong spectral lines of metals.
E. Open clusters have hotter and bluer bright stars.

549. If one region of the sky shows nearby stars but no distant stars or galaxies, our view is probably
A. being blocked by an interstellar dust cloud.
B. being blocked by cold interstellar gas.
C. being blocked by an emission nebula.
D. being blocked by many cool stars.
E. directed toward a particularly empty region of space.

550. Interstellar dust causes
A. cancer.
B. reddening of starlight.
C. black holes in space.
D. emission nebulae.
E. None of the other answers is correct.

551. Clouds rich in dust silhouetted against a bright background like the Horsehead are called _____ nebulae.
A. dark
B. planetary
C. reflection
D. bright
E. emission

552. In recent decades microwave telescopes discovered that
A. interstellar hydrogen is nearly all ionized.
B. large regions of interstellar space contain no gas.
C. surprisingly complex molecules exist in dark clouds.
D. interstellar dust reddens starlight.
E. interstellar hydrogen is nearly all in molecules.

553. The gas in H II regions is radiating under the influence of
A. cosmic rays.
B. energy derived from magnetic fields.
C. stars in the central region of the galaxy.
D. stars which have formed out of the nebulae.

554. What is the principal difference between an emission and a reflection nebula?
A. Only the reflection nebula contains dust.
B. The luminosity of the nearby stars differ.
C. The temperatures of the nearby stars differ.
D. The reflection nebula contains more hydrogen.

555. The bright, shining clouds of dust seen lying around the stars in the Pleiades Cluster are good examples of
A. solar nebulae.
B. reflection nebulae.
C. H I regions.
D. absorption nebulae.

556. The properties which collectively characterize Population I (disk population) stars are
A. found only in black holes, old ages.
B. low metal abundances, young ages, no massive stars.
C. higher metal abundances, younger ages, circular orbits.
D. low metal abundances, old ages, elongated orbits.

557. The best estimate of the mass of our Galaxy is the equivalent of about
A. 200 suns
B. 200 billion suns
C. 200,000,000 suns
D. 200 trillion suns
E. 200,000 suns

558. The diameter of our Galaxy is closest to
A. 100 light years
B. 100,000 light years
C. 1000 light years
D. 10,000 light years
E. 1,000,000 light years

559. Galactic cannibalism is a
A. reason why S0 galaxies contain much gas and dust.
B. confirmed cause of supernova explosions.
C. confirmed origin of dwarf elliptical galaxies.
D. significant factor only away from galaxy clusters.
E. possible origin of giant elliptical galaxies.

560. Which are the most common form of galaxies?
A. dwarf ellipticals
B. giant ellipticals
C. spirals

561. Elliptical galaxies comprise about _____ percent of all galaxies.
A. 50
B. 3
C. 15
D. 70
E. 25

562. Hubble discovered that spiral nebulae were outside our Galaxy by observing
A. RR Lyrae stars.
B. Cepheid variables.
C. supernovae.
D. the rotation of the nebulae.
E. novae.

563. The local group refers to
A. all stars within 100 light years of the Sun.
B. the white dwarfs in the vicinity of the Sun.
C. the small cluster of galaxies, to which our own belongs.
D. the Andromeda galaxy and its two companion galaxies.

564. The Magellanic Clouds are
A. cirrus clouds seen only in the southern hemisphere.
B. nearby elliptical galaxies.
C. small irregular galaxies and companions of the Milky Way.
D. the super-aggregate of which our own galaxy is a part.

565. All members of the list may be employed in the so-called "standard candle method" for gauging the distances of individual galaxies:
A. supernovae, red dwarfs
B. neutron stars, H II regions, Cepheids
C. globular clusters, H II regions, supernovae, Cepheids
D. red dwarfs, white dwarfs, neutron stars

566. A galaxy consisting primarily of old stars with very little cool gas and dust will be a(n)
A. elliptical
B. spiral
C. peculiar
D. irregular
E. quasar

567. The most luminous standard candles for measuring distances of clusters of galaxies are the
A. dwarf elliptical galaxies.
B. giant elliptical galaxies.
C. globular clusters.
D. irregular galaxies.
E. spiral galaxies.

568. A galaxy that has long "tails" reaching out into space is thought to be the result of
A. a galaxy which lacks a halo.
B. the collision of two galaxies.
C. the effects of magnetic fields.
D. a strong galactic wind.
E. several supernovae going off near the nucleus.

569. We would expect a galaxy with many bright blue stars
A. to contain no life.
B. to have much dust and gas.
C. to contain no stars like the Sun.
D. to have little or no dust and gas.
E. to have no old stars.

570. On average, the distance between galaxies is roughly a few million light years
A. True
B. False

571. According to the Hubble law, clusters of galaxies twice as far away move _____ us _____ faster.
A. towards, 2 x
B. away from, 4 x
C. towards, 4 2
D. away from, 2 x

572. The greater the distance of a galaxy away from the Earth, the greater the recessional velocity and so
A. the greater the observed blue shift.
B. the more massive it is.
C. the older it is.
D. the greater the observed red shift.

573. If the sky is photographed to locate other galaxies on a star chart, the galaxies that are seen
A. uniformly across the entire sky.
B. tend to occur near H II regions in the Milky Way.
C. occur more frequently near the Milky Way.
D. are clustered in the same part of the sky as globulars.
E. tend to be seen only rarely in the Milky Way.

574. The masses of spiral galaxies are calculated from their rotation curves by application of
A. Hubble's law.
B. Newton's second law.
C. Kepler's third law.
D. Newton's third law.
E. Kirchhoff's law.

575. The term "expansion of the universe" means
A. the distances between the galaxies increases with time.
B. supernovae explosions cause everything to fly apart.
C. some galaxies are exploding.
D. each galaxy is expanding.

576. The particle nature of light is demonstrated by
A. short wavelength of x-rays.
B. the interference effect.
C. the photelectri effect.
D. refractuion.

577. St. Augustine's question asks
A. how quasars produce radio lobes.
B. how quasars emit so much energy.
C. why the universe is now expanding.
D. why mass warps spacetime.
E. what led up to the creation of our universe.

578. The distances to stars more luminous and hotter than the Sun are usually found from
A. brightness
B. angular size
C. parallax
D. the "moving cluster" method

579. The mass-luminosity law for main sequence stars is based on accurate mass determinations for _____ stars.
A. several thousand
B. about one hundred
C. about ten

580. The order of the stages of evolution a star like our Sun goes through is
A. red giant, main sequence, pre-main sequence, white dwarf.
B. pre-main sequence, main sequence, red giant, white dwarf.
C. pre-main sequence, white dwarf, main sequence, red giant.
D. pre-main sequence, red giant, main sequence, white dwarf.
E. red giant, white dwarf, main sequence, pre-main sequence.

581. Which of the following has essentially no atmosphere?
A. Mars
B. Venus
C. Mercury
D. Earth
E. Jupiter

582. The outer Galilean moons of Jupiter are thought to consist primarily of
A. carbon dioxide and nitrogen.
B. hydrogen, methane, and ammonia.
C. ice, water, and rock.
D. metals and rock.

583. It is suspected that 'twin quasars' are
A. produced by a supernova explosion.
B. a double image produced by a defect in the telescope.
C. actually binary stars in the Milky Way.
D. two images of the same quasar produced by gravitation.
E. identical quasars orbiting each other.

584. Since distant galaxies all seem to be moving away from us, we are very close to the point of origin of the explosion that apparently produced the universe.
A. True.
B. False.

585. In the 'raisin-bread' analogy for the expansion of the universe the individual raisins represent
A. individual globular or galactic clusters.
B. individual clusters of galaxies.
C. individual planets.
D. individual stars.

586. For which theory might we expect to see differences between the nearest and the most remote galaxies?
A. Steady State
B. Big Bang

587. The cosmological principle states that all observers, everywhere in space, would
A. believe themselves to be at the center of space.
B. see total confusion.
C. view the same large scale picture of the universe.
D. be members of civilizations of the same maturity.

588. A study of the structure of the universe as a single, orderly system is
A. history
B. comic
C. cosmology
D. cosmotology
E. cosmogony

589. If the quasars are indeed the very most distant objects in the universe, then the Steady State theory must be wrong.
A. False.
B. True.

590. A basic premise of the Steady State theory is that conditions in the universe are similar
A. only everywhere but not always.
B. everywhere and always.
C. only always but not everywhere.

591. One method of keeping the universe in a Steady State is to postulate
A. the steady expansion of the universe.
B. the rotation of galaxies.
C. the spontaneous creation of matter.
D. the production of supernovae.

592. Quasars
A. have the same luminosity as giant elliptical galaxies.
B. have absorption lines but rarely have emission lines.
C. should be more common in the future than in the past.
D. were more common when the universe was younger.
E. probably have less than a thousand solar masses.

593. One successful test of the Big Bang theory for the origin of the universe is that it gives
A. very few neutrinos.
B. the correct amounts of hydrogen and helium in old stars.
C. redshifts of galaxies independent of distance.
D. more atoms than photons in the universe.
E. an age of the universe of about 100 billion years.

594. In the outline of the Big Bang cosmology, all of the matter and radiation in the universe was occupying a tiny volume approximately _____ years ago.
A. fifteen billion
B. one billion
C. one hundred million
D. one hundred billion

595. One successful test of the Big Bang theory for the origin of the universe is that it gives
A. more atoms than photons in the universe.
B. quasars close to the Milky Way.
C. blue shifts for a few very distant galaxies.
D. equal amounts of hydrogen and helium.
E. an age of the universe near the ages of the oldest stars.

596. The primeval atom contained how much mass?
A. 1 billion solar masses
B. 1 million solar masses
C. all the mass in the universe
D. 4 solar masses
E. 6 protons and 6 neutrons

597. Which elements were present when the universe was 500 seconds old?
A. hydrogen
B. only elements heavier than iron
C. all the elements now present
D. hydrogen and helium

598. The two principal lines of observational evidence for the Big Bang theory of the universe are the _____ and the _____.
A. velocity-distance relation; distribution of quasars
B. 3-degree background radiation; velocity-distance relation
C. velocity-distance relation; superclustering of galaxies
D. distribution of quasars; superclustering of galaxies
E. distribution of quasars; 3-degree background radiation

599. Which one of these is a name for the source of 3 radio and microwave emission coming from the entire sky?
A. quasar
B. primeval fireball
C. giant elliptical
D. galaxy

600. Roughly how old was the universe when it became transparent?
A. 10,000 years
B. 300,000 years
C. The universe was always transparent.
D. 1 billion years
E. 100 years

601. If the Big Bang theory is correct, and there is not sufficient density to close the universe, then
A. Big Bangs will occur sequentially.
B. matter will be continually created.
C. the universe will eventually die.

602. If the universe is closed
A. the galaxies will expand forever.
B. Hubble's law must be wrong.
C. it will become static.
D. it will fall back in on itself creating another fireball.

603. The present data seem to indicate that the universe will probably
A. eventually recollapse.
B. eventually stop expanding and become static.
C. separate into two or more parts.
D. expand forever.
E. None of the other answers are correct.

604. What determines the look-back time for an object?
A. temperature
B. distance
C. luminosity
D. mass
E. All of these.