Review for Astronomy 5 Midterm and Final

Midterm covers first 70 questions, Final covers all 105.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. Chapter 1 is covered by Q1-4; Ch. 2 Q5-13; Ch. 3 Q14-21; Ch. 4 Q22-28; Ch. 5 Q29-38; Ch. 6 Q39-43; Ch. 14 Q44-49; Ch. 15 Q50-60; Ch. 16 Q61-65; Ch. 17 Q66-73; Ch. 18 Q74-82; Ch. 19 Q83-87; Ch. 20 Q88-94; Ch. 21 Q95-96; Ch. 22 Q97-100; Ch. 23 Q101-105

1) Which of the following has your "address" in the correct order?
   A) you, Earth, solar system, Milky Way, Local Group, Local Supercluster
   B) you, Earth, solar system, Local Group, Milky Way, Local Supercluster
   C) you, Earth, solar system, Local Group, Local Supercluster, Milky Way
   D) you, Earth, Local Group, Local Supercluster, solar system, Milky Way
   E) you, Earth, solar system, Milky Way, Local Supercluster, Local Group

2) Roughly how many stars are in the Milky Way Galaxy?
   A) 10 billion
   B) 1 billion
   C) 100 million
   D) 100 trillion
   E) 100 billion

3) Which scientists played a major role in overturning the ancient idea of an Earth–centered universe, and about when?
   A) Aristotle and Copernicus; about 400 years ago
   B) Huygens and Newton; about 300 years ago
   C) Copernicus, Kepler, and Galileo; about 400 years ago
   D) Newton and Einstein; about 100 years ago
   E) Aristotle and Plato; about 2,000 years ago

4) What is an *astronomical unit*?
   A) the average distance from Earth to the Sun
   B) any basic unit used in astronomy
   C) the length of time it takes Earth to revolve around the Sun
   D) the average speed of Earth around the Sun
   E) the diameter of Earth's orbit around the Sun

5) Which of the following statements about the celestial sphere is *not* true?
   A) The celestial sphere does not exist physically.
   B) Earth is placed at the center of the celestial sphere.
   C) The "celestial sphere" is just another name for our universe.
   D) From any location on Earth, we can see only half the celestial sphere at any one time.
   E) When we look in the sky, the stars all appear to be located on the celestial sphere.

6) Which of the following statements about the celestial equator is true at *all* latitudes?
   A) It cuts the dome of your sky exactly in half.
   B) It lies along the band of light we call the Milky Way.
   C) It represents an extension of Earth's equator onto the celestial sphere.
   D) It extends from your horizon due north, through your zenith, to your horizon due south.
   E) It extends from your horizon due east, through your zenith, to your horizon due west.

7) What is the *ecliptic*?
   A) the Moon's apparent path along the celestial sphere
   B) the Sun's apparent path along the celestial sphere
   C) when the Moon passes in front of the Sun
   D) the Sun's daily path across the sky
   E) the constellations commonly used in astrology to predict the future

8) Which of the following correctly describes the *meridian* in your sky?
   A) a half–circle extending from your horizon due north, through your zenith, to your horizon due south
   B) the boundary between the portion of the celestial sphere you can see at any moment and the portion that you cannot see
   C) a half–circle extending from your horizon due east, through your zenith, to your horizon due west
   D) a half–circle extending from your horizon due east, through the north celestial pole, to your horizon due west
   E) the point directly over your head

9) How many arcseconds are in 1°?
   A) 100
   B) 3,600
   C) 60
   D) 10,000
   E) 360

10) What is a *circumpolar* star?
   A) a star that always remains above your horizon
   B) a star that is close to the south celestial pole
   C) a star that is close to the north celestial pole
   D) a star that makes a daily circle around the celestial sphere
   E) a star that is visible from the Arctic or Antarctic circles

11) Which of the following is *not* a phase of the Moon?
   A) third–quarter Moon
   B) first–quarter Moon
   C) half Moon
   D) full Moon
   E) new Moon

12) If the Moon is setting at 6 A.M., the phase of the Moon must be
A) third quarter.
B) first quarter.
C) waning crescent.
D) full.
E) new.

13) Which of the following never goes in retrograde motion?
A) Jupiter
B) Venus
C) the Sun
D) Saturn
E) Mars

14) How did Eratosthenes estimate the size of Earth in 240 B.C.?
A) by measuring the size of Earth's shadow on the Moon in a lunar eclipse
B) by sending fleets of ships around Earth
C) by comparing the maximum altitude of the Sun in two cities at different latitudes
D) by observing the duration of a solar eclipse
E) We don't know how he did it since all his writings were destroyed.

15) Why did Ptolemy have the planets orbiting Earth on "circles upon circles" in his model of the universe?
A) to explain the fact that planets sometimes appear to move westward, rather than eastward, relative to the stars in our sky
B) to properly account for the varying distances of the planets from Earth
C) to explain why more distant planets take longer to make a circuit through the constellations of the zodiac
D) to explain why the Greeks were unable to detect stellar parallax
E) to explain why Venus goes through phases as seen from Earth

16) Where was the Sun in Ptolemy's model of the universe?
A) slightly offset from the center
B) at the center
C) at the outer edge, beyond Saturn's orbit
D) between the orbits of Venus and Mars
E) between Earth and the Moon's orbit

17) The controversial book of this famous person, published in 1543 (the year of his death), suggested that Earth and other planets orbit the Sun.
A) Galileo
B) Tycho Brahe
C) Ptolemy
D) Kepler
E) Copernicus

18) He discovered that the orbits of planets are ellipses.
A) Ptolemy
B) Galileo
C) Tycho Brahe
D) Copernicus
E) Kepler

19) He discovered that Jupiter has moons.
A) Aristotle
B) Tycho Brahe
C) Ptolemy
D) Kepler
E) Galileo

20) From Kepler's third law, an asteroid with an orbital period of 8 years lies at an average distance from the Sun equal to
A) 2 astronomical units.
B) 4 astronomical units.
C) 8 astronomical units.
D) 16 astronomical units.
E) It depends on the asteroid's mass.

21) What is meant by a *hypothesis*?
A) an explanation for a phenomenon that makes a prediction
B) a historical theory that has been proved inaccurate
C) a natural phenomenon that requires explanation
D) a tentative understanding of a natural phenomenon
E) a pseudoscientific idea

22) If your mass is 60 kg on Earth, what would your mass be on the Moon?
A) 10 kg B) 60 lb C) 10 lb D) 60 kg E) 50 kg

23) What would happen if the Space Shuttle were launched with a speed greater than Earth's *escape velocity*?
A) It would orbit Earth at a faster velocity.
B) It would be in an unstable orbit.
C) It would travel away from Earth into the solar system.
D) It would travel in a higher orbit around Earth.
E) It would take less time to reach its bound orbit.

24) The movement of a pool ball, after being struck by a cue, is an example of
A) Newton's second law of motion.
B) conservation of momentum.
C) Newton's third law of motion.
D) the universal law of gravitation.
E) Newton's first law of motion.

25) The force of gravity is an inverse square law. This means that, if you double the distance between two large masses, the gravitational force between them
A) is unaffected.
B) strengthens by a factor of 4.
C) weakens by a factor of 2.
D) weakens by a factor of 4.
E) also doubles.

26) According to the *universal law of gravitation*, if you double the masses of *both* attracting objects, then the gravitational force between them will
A) not change at all.
B) increase by a factor of 2.
C) decrease by a factor of 2.
D) decrease by a factor of 4.
E) increase by a factor of 4.

27) The mass of Jupiter can be calculated by
A) measuring the orbital period and distance of one of Jupiter's moons.
B) measuring the orbital period and distance of Jupiter's orbit around the Sun.
C) measuring the orbital speed of one of Jupiter's moons.
D) knowing the Sun's mass and measuring how Jupiter's speed changes during its elliptical orbit around the Sun.
E) knowing the Sun's mass and measuring the average distance of Jupiter from the Sun.

28) At which lunar phase(s) are tides most pronounced (e.g., the highest high tides)?
A) full Moon
B) first quarter
C) new Moon
D) both new and full Moons
E) both first and third quarters

29) An atom in an *excited state* contains more of what type of energy than the same atom in the *ground state*?
A) thermal energy
B) electric potential energy
C) mass–energy
D) kinetic energy
E) gravitational potential energy

30) If a material is highly *opaque*, then it
A) scatters most light.
B) emits most light.
C) transmits most light.
D) absorbs most light.
E) reflects most light.

31) The *wavelength* of a wave is
A) the distance between where the wave is emitted and where it is absorbed.
B) equal to the speed of the wave times the wave's frequency.
C) the distance between a peak of the wave and the next trough.
D) the distance between two adjacent peaks of the wave.
E) how strong the wave is.

32) How are wavelength, frequency, and energy related for photons of light?
A) Longer wavelength means lower frequency and higher energy.
B) Longer wavelength means lower frequency and lower energy.
C) Longer wavelength means higher frequency and higher energy.
D) Longer wavelength means higher frequency and lower energy.
E) There is no simple relationship because different photons travel at different speeds.

33) From lowest energy to highest energy, which of the following correctly orders the different categories of electromagnetic radiation?
A) visible light, infrared, X rays, ultraviolet, gamma rays, radio
B) radio, infrared, visible light, ultraviolet, X rays, gamma rays
C) infrared, visible light, ultraviolet, X rays, gamma rays, radio
D) radio, X rays, visible light, ultraviolet, infrared, gamma rays
E) gamma rays, X rays, visible light, ultraviolet, infrared, radio

34) When an atom loses an electron, it becomes
A) dissociated.
B) a plasma.
C) an isotope.
D) ionized.
E) sublimated.

35) When an electron in an atom goes from a higher energy state to a lower energy state, the atom
A) absorbs a photon of a specific frequency.
B) can absorb a photon of any frequency.
C) absorbs several photons of a specific frequency.
D) can emit a photon of any frequency.
E) emits a photon of a specific frequency.

36) If two objects are the same size but one object is 3 times hotter than the other object, the hotter object emits
A) 81 times more energy.
B) 9 times more energy.
C) 3 times more energy.
D) 12 times more energy.
E) none of the above

37) The spectra of most galaxies show redshifts. This means that their spectral lines
A) have a higher intensity in the red part of the spectrum.
B) have normal wavelengths, but absorption of light makes them appear red.
C) always are in the red part of the visible spectrum.
D) have wavelengths that are longer than normal.
E) have wavelengths that are shorter than normal.

38) From laboratory measurements, we know that a particular spectral line formed by hydrogen appears at a wavelength of 121.6 nanometers (nm). The spectrum of a particular star shows the same hydrogen line appearing at a wavelength of 121.8 nm. What can we conclude?
A) The "star" actually is a planet.
B) The star is moving away from us.
C) The star is getting colder.
D) The star is moving toward us.
E) The star is getting hotter.

39) Telescopes operating at this wavelength must be cooled to observe faint astronomical objects.
A) extreme infrared
B) visible
C) gamma–ray
D) radio
E) X–ray

40) Suppose the angular separation of two stars is smaller than the angular resolution of your eyes. How will the stars appear to your eyes?
A) The two stars will look like a single point of light.
B) You will see only the larger of the two stars, not the smaller one.
C) The two stars will appear to be touching, looking rather like a small dumbbell.
D) You will not be able to see these two stars at all.
E) You will see two distinct stars.

41) Which of the following statements best describes the two principal advantages of telescopes over eyes?
A) Telescopes have much more magnification and better angular resolution.
B) Telescopes can see farther without image distortion and can record more accurate colors.
C) Telescopes can collect far more light with far greater magnification.
D) Telescopes can collect far more light with far better angular resolution.
E) Telescopes collect more light and are unaffected by twinkling.

42) Which of the following is *not* an advantage of the Hubble Space Telescope over ground–based telescopes?
A) Stars do not twinkle when observed from space.
B) It is closer to the stars.
C) It never has to close because of bad weather.
D) It can observe infrared and ultraviolet light, as well as visible light.
E) Observers on the ground can use it at any time of day (i.e., not only during their night).

43) In what part of the electromagnetic spectrum do the biggest telescopes on Earth operate?
A) visible
B) radio
C) X–ray
D) infrared
E) ultraviolet

44) The core of the Sun is
A) constantly rising to the surface through convection.
B) hotter and denser than the surface.
C) at the same temperature and density as the surface.
D) at the same temperature but denser than the surface.
E) composed of iron.

45) What two forces are balanced in what we call *gravitational equilibrium*?
A) the strong force and gravity
B) the electromagnetic force and gravity
C) outward pressure and gravity
D) outward pressure and the strong force
E) the strong force and kinetic energy

46) What is the average temperature of the *surface* of the Sun?
A) 6,000 K
B) 10,000 K
C) 1,000 K
D) 1 million K
E) 100,000 K

47) Which layer of the Sun do we normally see?
A) corona
B) convection zone
C) chromosphere
D) radiation zone
E) photosphere

48) At the center of the Sun, fusion converts hydrogen into
A) plasma.
B) helium, energy, and neutrinos.
C) hydrogen compounds.
D) radioactive elements like uranium and plutonium.
E) radiation and elements like carbon and nitrogen.

49) What is *granulation* in the Sun?
A) another name for the way sunspots look on the surface of the Sun
B) the bubbling pattern on the photosphere produced by the underlying convection
C) lumps of denser material in the Sun
D) dust particles in the Sun that haven't been turned into plasma
E) elements in the Sun other than hydrogen and helium

50) Approximately, what basic composition are all stars born with?
A) one–quarter hydrogen, three–quarters helium, no more than 2 percent heavier elements
B) three–quarters hydrogen, one–quarter helium, no more than 2 percent heavier elements
C) half hydrogen, half helium, no more than 2 percent heavier elements
D) 98 percent hydrogen, 2 percent helium
E) 90 percent hydrogen, 10 percent helium, no more than 1 percent heavier elements

51) Since all stars begin their lives with the same basic composition, what characteristic most determines how they will differ?
A) location where they are formed
B) luminosity they are formed with
C) color they are formed with
D) time they are formed
E) mass they are formed with

52) A star's *luminosity* is the
A) apparent brightness of the star in our sky.
B) total amount of light that the star radiates each second.
C) total amount of light that the star will radiate over its entire lifetime.
D) surface temperature of the star.
E) lifetime of the star.

53) If the distance between us and a star is doubled, with everything else remaining the same, the luminosity
A) is decreased by a factor of two, and the apparent brightness is decreased by a factor of two.
B) is decreased by a factor of four, but the apparent brightness remains the same.
C) remains the same, but the apparent brightness is decreased by a factor of two.
D) remains the same, but the apparent brightness is decreased by a factor of four.
E) is decreased by a factor of four, and the apparent brightness is decreased by a factor of four.

54) Suppose that you measure the parallax angle for a particular star to be 0.5 arcsecond. The distance to this star is
A) 0.5 parsec.
B) 0.5 light–year.
C) 5 parsecs.
D) 5 light–years.
E) 2 parsecs.

55) The spectral sequence sorts stars according to
A) radius.
B) core temperature.
C) surface temperature.
D) mass.
E) luminosity.

56) Which of the following terms is given to a pair of stars that appear to change positions in the sky, indicating that they are orbiting one another?
A) visual binary
B) spectroscopic binary
C) eclipsing binary
D) double star
E) none of the above

57) On a Hertzsprung–Russell diagram, where would we find stars that are cool and dim?
A) upper right
B) center
C) upper left
D) lower right
E) lower left

58) On a Hertzsprung–Russell diagram, where on the main sequence would we find stars that have the greatest mass?
A) lower left
B) center
C) upper left
D) lower right
E) upper right

59) The spectral sequence in order of decreasing temperature is
A) OBAGFKM.
B) OFBAGKM.
C) BAGFKMO.
D) ABFGKMO.
E) OBAFGKM.

60) Which of the following best describes the axes of a Hertzsprung–Russell (H–R) diagram?
A) surface temperature on the horizontal axis and radius on the vertical axis
B) mass on the horizontal axis and stellar age on the vertical axis
C) surface temperature on the horizontal axis and luminosity on the vertical axis
D) mass on the horizontal axis and luminosity on the vertical axis
E) interior temperature on the horizontal axis and mass on the vertical axis

61) The typical size of an interstellar dust grain is
A) 1 nanometer.
B) 1 millimeter.
C) 1 centimeter.
D) 1 angstrom.
E) 1 micrometer.

62) If you wanted to observe a molecular cloud, in what wavelength of light would you most likely observe?
A) gamma–ray
B) X–ray
C) visible
D) infrared
E) ultraviolet

63) What is the likely reason that we cannot find any examples of the first generation stars?
A) The first generation stars formed such a long time ago that the light from them has not yet had time to reach us.
B) The first generation stars formed with only H and He and therefore have no spectral features.
C) We do not know how the first generation stars were formed.
D) The first generation stars were all very massive and exploded as supernova.
E) The first generation stars are too faint to be visible now.

64) What happens to the surface temperature and luminosity when gravity first assembles a protostar from a collapsing cloud?
A) Its surface temperature and luminosity decrease.
B) Its surface temperature remains the same and its luminosity decreases.
C) Its surface temperature and luminosity remain the same.
D) Its surface temperature decreases and its luminosity increases.
E) Its surface temperature and luminosity increase.

65) What is the smallest mass a newborn star can have?
A) 80 times the mass of Jupiter
B) about 1/80 the mass of our Sun
C) about 1/800 the mass of our Sun
D) 800 times the mass of Jupiter
E) 8 times the mass of Jupiter

66) What happens when a star exhausts its core hydrogen supply?
A) It expands, becoming bigger but dimmer.
B) Its core contracts, but its outer layers expand and the star becomes bigger but cooler and therefore remains at the same brightness.
C) It contracts, becoming smaller and dimmer.
D) Its core contracts, but its outer layers expand and the star becomes bigger and brighter.
E) It contracts, becoming hotter and brighter.

67) Compared to the star it evolved from, a red giant is
A) hotter and dimmer.
B) the same temperature and brightness.
C) hotter and brighter.
D) cooler and brighter.
E) cooler and dimmer.

68) How many helium nuclei fuse together when making carbon?
A) 4
B) 3
C) 2
D) varies depending on the reaction
E) none of the above

69) What is a planetary nebula?
A) the expanding shell of gas that is no longer gravitationally held to the remnant of a low–mass star
B) the expanding shell of gas that is left when a white dwarf explodes as a supernova
C) the molecular cloud from which protostars form
D) what is left of the planets around a star after a low–mass star has ended its life
E) a disk of gas surrounding a protostar that may form into planets

70) Which of the following sequences correctly describes the stages of life for a low–mass star?
A) protostar, red giant, main–sequence, white dwarf
B) protostar, main–sequence, red giant, white dwarf
C) protostar, main–sequence, white dwarf, red giant
D) red giant, protostar, main–sequence, white dwarf
E) white dwarf, main–sequence, red giant, protostar

71) What happens when the gravity of a massive star is able to overcome *neutron* degeneracy pressure?
A) The core contracts and becomes a ball of neutrons.
B) Gravity is not able to overcome neutron degeneracy pressure.
C) The core contracts and becomes a white dwarf.
D) The star explodes violently, leaving nothing behind.
E) The core contracts and becomes a black hole.

72) After a supernova event, what is left behind?
A) either a white dwarf or a neutron star
B) always a black hole
C) either a neutron star or a black hole
D) always a neutron star
E) always a white dwarf

73) Why is Supernova 1987A particularly important to astronomers?
A) It was the first supernova detected in nearly 400 years.
B) It provided the first evidence that neutron stars really exist.
C) It was the nearest supernova detected in nearly 400 years.
D) It occurred only a few dozen light–years from Earth.
E) It provided the first evidence that supernovae really occur.

74) White dwarfs are so called because
A) they are supported by electron degeneracy pressure.
B) they are both very hot and very small.
C) they are the end–products of small, low–mass stars.
D) it amplifies the contrast with red giants.
E) they are the opposite of black holes.

75) What kind of pressure supports a white dwarf?
A) electron degeneracy pressure
B) thermal pressure
C) neutron degeneracy pressure
D) radiation pressure
E) all of the above

76) How does a 1.2–solar–mass white dwarf compare to a 1.0–solar–mass white dwarf?
A) It has a smaller radius.
B) It has a higher surface temperature.
C) It has a larger radius.
D) It has a lower surface temperature.
E) It is supported by neutron, rather than electron, degeneracy pressure.

77) Which of the following is closest in size (radius) to a white dwarf?
A) a basketball
B) Earth
C) the Sun
D) a football stadium
E) a small city

78) Which of the following is closest in size (radius) to a neutron star?
A) a city
B) Earth
C) the Sun
D) a basketball
E) a football stadium

79) From a theoretical standpoint, what is a pulsar?
A) a neutron star or black hole that happens to be in a binary system
B) a star that alternately expands and contracts in size
C) a rapidly rotating neutron star
D) a binary system that happens to be aligned so that one star periodically eclipses the other
E) a star that is burning iron in its core

80) What is the basic definition of a *black hole*?
A) any object made from dark matter
B) a dead star that has faded from view
C) any object from which the escape velocity exceeds the speed of light
D) a dead galactic nucleus that can only be viewed in infrared
E) any compact mass that emits no light

81) Which of the following statements about black holes is *not* true?
A) If you fell into a black hole, you would experience time to be running normally as you plunged rapidly across the event horizon.
B) If the Sun magically disappeared and was replaced by a black hole of the same mass, Earth would soon be sucked into the black hole.
C) If we watch a clock fall toward a black hole, we will see it tick slower and slower as it falls nearer to the black hole.
D) If you watch someone else fall into a black hole, you will never see him or her cross the event horizon. However, he or she will fade from view as the light he or she emits (or reflects) becomes more and more redshifted.
E) A black hole is truly a hole in spacetime, through which we could leave the observable universe.

82) If you were to come back to our Solar System in 6 billion years, what might you expect to find?
A) a white dwarf
B) a black hole
C) a rapidly spinning pulsar
D) a red giant star
E) Everything will be pretty much the same as it is now.

83) What is the diameter of the disk of the Milky Way?
A) 10,000 light-years
B) 1,000,000 light-years
C) 1,000 light-years
D) 100 light-years
E) 100,000 light-years

84) Which of the following comprise the oldest members of the Milky Way?
A) Cepheid variables
B) the Sun and other solar mass stars
C) O stars
D) red giant stars in spiral arms
E) globular clusters

85) What produces the 21–cm line that we use to map out the Milky Way Galaxy?
A) atomic hydrogen
B) molecular hydrogen
C) carbon monoxide
D) ionized hydrogen
E) helium

86) Approximately how long does it take the Sun to orbit the Milky Way Galaxy?
A) 230,000 years
B) 230 million years
C) 2.3 million years
D) 23,000 years
E) 23 billion years

87) Which constellation lies in the direction toward the galactic center?
A) Orion
B) Sagittarius
C) Taurus
D) the Big Dipper
E) Leo

88) Compared to spiral galaxies, elliptical galaxies are
A) bluer and rounder.
B) redder and rounder.
C) always much smaller.
D) redder and flattened.
E) bluer and flattened.

89) The disk component of a spiral galaxy includes which of the following parts?
A) bulge
B) spiral arms
C) halo
D) globular clusters
E) all of the above

90) Why are Cepheid variables important?
A) Cepheids are a type of young galaxy that helps us understand how galaxies form.
B) Cepheid variables are stars that vary in brightness because they harbor a black hole.
C) Cepheids are pulsating variable stars, and their pulsation periods are directly related to their true luminosities. Hence, we can use Cepheids as "standard candles" for distance measurements.
D) Cepheids are supermassive stars that are on the verge of becoming supernovae and therefore allow us to choose candidates to watch if we hope to observe a supernova in the near future.

91) What is *Hubble's law*?
A) The faster a spiral galaxy's rotation speed, the more luminous it is.
B) The recession velocity of a galaxy is directly proportional to its distance from us.
C) The longer the time period between peaks in brightness, the greater the luminosity of the Cepheid variable star.
D) The faster a spiral galaxy's rotation speed, the less luminous it is.
E) The recession velocity of a galaxy is inversely proportional to its distance from us.

92) What is the most accurate way to determine the distance to a very distant irregular galaxy?
A) Hubble's law
B) using a white–dwarf supernova as a standard candle
C) the Tully–Fisher relation
D) using Cepheid variables
E) main–sequence fitting

93) Based on current estimates of the value of Hubble's constant, how old is the universe?
A) between 12 and 16 billion years old
B) between 4 and 6 billion years old
C) between 8 and 12 billion years old
D) between 20 and 40 billion years old
E) between 16 and 20 billion years old

94) I observe a galaxy that is 100 million light-years away: what do I see?
A) the light from the galaxy as it is today, but it is blueshifted
B) the light from the galaxy as it is today, but it is redshifted
C) the light from the galaxy as it was 100 million years ago and it it blueshifted
D) the light from the galaxy as it was 100 million years ago and it is redshifted
E) Nothing: the galaxy lies beyond the cosmological horizon.

95) Why should galaxy collisions have been more common in the past than they are today?
A) Galaxies were much bigger in the past since they had not contracted completely.
B) Galaxies were more active in the past and therefore would have collided with each other more frequently.
C) Galaxy collisions shouldn't have been more common in the past than they are now.
D) Galaxies were closer together in the past because the universe was smaller.
E) Galaxies attracted each other more strongly in the past because they were more massive; they had not yet turned most of their mass into stars and light.

96) What is a *quasar*?
A) the extremely bright center of a distant galaxy, thought to be powered by a massive black hole
B) a specialized astronomical instrument for observing distant stars
C) another name for very bright stars of spectral type O
D) a very large galaxy thought to be formed by the merger of several smaller galaxies, typically found in the center of a galaxy cluster
E) a starlike object that actually represents a bright patch of gas in the Milky Way

97) What is meant by "dark energy"?
A) any unknown force that opposes gravity
B) highly energetic particles that are believed to constitute dark matter
C) the agent causing the universal expansion to accelerate
D) the energy associated with dark matter through $E=mc^2$
E) the total energy in the Universe after the Big Bang but before the first stars

98) The distribution of the dark matter in a spiral galaxy is
A) approximately spherical and about the same size as the galaxy halo.
B) flattened in a disk and about the same size as the stellar disk.
C) approximately spherical and about ten times the size of the galaxy halo.
D) flattened in a disk but about ten times larger than the stellar disk.
E) predominantly concentrated in the spiral arms.

99) If all the "dark matter" in the Universe were to be, somehow, instantaneously removed, which of the following would *not* happen?
A) Clusters of galaxies would fly apart.
B) The Universe would expand forever.
C) The Milky Way would fly apart.
D) The Solar System would fly apart.
E) all of the above

100) What is the evidence for an accelerating universe?
A) White–dwarf supernovae are the same brightness regardless of redshift.
B) There is far more dark matter than visible matter in the universe.
C) The Andromeda Galaxy is moving away from the Milky Way at an ever–increasing speed.
D) White–dwarf supernovae are slightly dimmer than expected for a coasting universe.
E) White–dwarf supernovae are slightly brighter than expected for a coasting universe.

101) To date, physicists have investigated the behavior of matter and energy at temperatures as high as those that existed in the universe as far back as _____ after the Big Bang.
A) 300 years
B) 300,000 years
C) 1 million years
D) 10^{-10} second
E) 3 minutes

102) What do we mean by *inflation*?
A) the separation that occurs after two photons collide and create a particle and an antiparticle
B) a sudden expansion of the universe after the strong force froze out from the GUT force
C) the sudden release of photons when a particle and antiparticle annihilate each other
D) the expansion of the universe that we still observe today
E) what happened the instant after the Big Bang

103) What kinds of atomic nuclei formed during the *era of nucleosynthesis*?
A) nuclei of all the chemical elements
B) only helium
C) only hydrogen
D) roughly equal amounts of each of the following: hydrogen, helium, lithium, beryllium, and boron
E) hydrogen and helium and trace amounts of lithium, beryllium, and boron

104) Why did the *era of nuclei* end when the universe was about 300,000 years old?
A) Photons were finally able to escape the plasma of the early universe and no longer heated the hydrogen and helium ions.
B) All the free particles had combined to form the nuclei of atoms.
C) The universe had expanded and cooled to a temperature of about 3,000 K, cool enough for stable, neutral atoms to form.
D) Neutrinos and electrons were finally able to escape the plasma of the early universe and no longer heated the other particles.
E) No theory can explain this.

105) Olbers' paradox is an apparently simple question, but its resolution suggests that the universe is finite in age. What is the question?
A) How does the Sun produce energy?
B) What would it be like to ride on a beam of light?
C) Why is the sky dark at night?
D) How many stars are in the universe?
E) Can we measure the position and momentum of an electron at the same time?