Fall 2003 **Exam 3** Name_____

The Cosmic System

Multiple Choice: Choose the answer that is the MOST correct.

1. A type of star cluster that contains mostly very old stars is
    a. An open star cluster
    b. A star system
    c. A globular star cluster
    d. An HII region

2. How are globular cluster distributed in our Milky Way Galaxy?
    a. Completely randomly
    b. Only in the main spiral disk
    c. Mostly in a large spherical halo surrounding the flat disk of the galaxy
    d. Only in the very center of the galaxy

3. Which of the following statements about open clusters of stars is FALSE?
    a. They typically contain more mass than any other type of cluster
    b. They are found mostly in the disk of our Galaxy
    c. They contain mostly young stars
    d. The stars in them are not as densely packed as stars in globulars

4. The oldest structures in our Galaxy turn out to be
    a. HII regions
    b. Open clusters
    c. Globular clusters
    d. Giant molecular clouds

5. If two galaxies collide

a. stars within them will not collide
b. 10% of the stars within them will merge
c. most stars will form binary pairs
d. galaxies never collide

6. Which is NOT a galaxy classification:
   a. spiral
   b. barred spiral
   c. ellipsoidal
   d. irregular

7. A gravitationally bound collection of 100 to 1000 stars located in the disk of a galaxy is called
   a. a stellar association
   b. a globular cluster
   c. an open cluster
   d. a star group

8. According to many astronomers, the core of our galaxy is host to
   a. a supermassive black hole
   b. a white dwarf
   c. a globular cluster
   d. our Solar System

9. The rapid rotation observed in the outer disk of the galaxy suggests
   a. the galaxy is more massive than previously thought
   b. the galaxy is losing mass
   c. the galaxy is gaining mass
   d. the galaxy is less massive than models predict

9. Cepheid variables have the property that
   a. the longer their period the higher their intrinsic luminosity
   b. the longer their period the further away they are
   c. the longer their period the redder they are
   d. the longer their period the closer they are

11. Most of the mass of a galaxy is
    a. contained in massive O and B stars
    b. contained in the HII regions of the galaxy
    c. contained in the dark matter of the galaxy
    d. contained in the disk of the galaxy

12. Population II stars
    a. Are primarily found in the disk of the galaxy
    b. Contain more heavy metals than population I stars
    c. Are located in globular clusters
    d. Are primarily young, hot O-B stars

13. Galaxies rich in gas and dust
    a. generally appear bluer
    b. have active star formation
    c. contain hot, bright stars
    d. all of the above

14. The rotation curve of a galaxy can be used to determine
    a. the relative number of hot young stars in the galaxy
    b. the mass of the galaxy
    c. the radius of the galaxy
    d. the luminosity of the galaxy

15. An irregular galaxy
    a. has no obvious nuclear bulge or spiral arms
    b. has no star formation
    c. has no interstellar gas
    d. has fewer stars than a regular galaxy

16. By comparing a Cepheid variable's absolute magnitude to its apparent magnitude we can
    a. calculate its luminosity
    b. determine its period

c. determine the distance to it
d. calculate its temperature

17. Herschel thought that the Sun and Earth were roughly at the center of the Milky Way, but this is not the case. What was the reason that Herschel did not realize our true position in the Milky Way?
    a. he did not have a telescope, and most stars are too far away to see without a telescope
    b. his telescope was only able to show him objects inside the solar system, and not objects in the Galaxy
    c. the dust that extends throughout the disk of the Galaxy only allowed Herschel to see the small part of it that is all around us
    d. there are so many black holes in the Galaxy, that they absorb a substantial part of the light from distant objects; we needed x-ray astronomy to see to more distant regions

18. What objects did Harlow Shapley use as "signposts" to figure out the extent of the Milky Way Galaxy and the location of its center?
    a. thick clouds of cold hydrogen giving off 21-cm radiation
    b. globular clusters
    c. HII regions
    d. dust clouds

19. What have we learned from the work of Harlow Shapley and others about the location of the Sun in the Milky Way Galaxy?
    a. we are almost exactly in the center of a giant flat pinwheel
    b. we are very close the edge of the visible disk of the Galaxy, about 50,000 LY from the center
    c. we are high above the disk of the Galaxy, about as far away as the most distant globular cluster
    d. we are in the disk of the Galaxy, about 3/5 of the way from the center

20. An astronomer needs to measure the distance to a globular cluster of stars that is part of the Milky Way Galaxy. What method should she try to use to find the distance?
    a. measure the parallax of the cluster
    b. find a variable star (Cepheid or RR Lyrae) in the cluster
    c. count the number of O and B type stars in the cluster
    d. look for flickering x-rays coming from a black hole in a binary star system in the cluster

21. Which of the following statements about the nuclear bulge of our Galaxy is FALSE?
    a. it is significantly thicker than the disk of the Galaxy
    b. it typically consists of older stars

c. it is difficult for us to see with visible light because of cosmic dust
d. the best way to learn more about it is to observe higher energy radiation, such as ultraviolet and x-rays

22. You suddenly get an uncontrollable urge to find out more about the other side of the Milky Way Galaxy (the regions beyond the center). Where should you rush off to?
    a. the control room of the Hubble Space Telescope at NASA
    b. a radio telescope that can observe at 21-cm wavelengths
    c. the control room of the Compton Gamma-Ray Observatory
    d. a gold mine near Lead, South Dakota

23. Radio astronomy has played a pivotal role in showing us the detailed structure of the Milky Way Galaxy. Which of the following techniques would one use as an essential part of an investigation of this structure?
    a. measuring the Doppler shift of a line in a spectrum
    b. taking a photograph of the sky in the direction of the Big Dipper
    c. using a CCD and a filter to record the amount of light from the stars in an open cluster
    d. measuring the amount of synchrotron radiation from the Crab Nebula

24. Where would you look for the youngest stars in the Milky Way Galaxy?
    a. in the halo
    b. where there is dark matter
    c. in the disk
    d. in the nuclear bulge

25. Objects orbiting around the center of the Milky Way obey Kepler's 3rd Law. This means that:
    a. the pull of gravity gets stronger and stronger as you get further away from the center
    b. larger clusters of stars will orbit the center more quickly than smaller ones
    c. the closer a star is to the center, the longer it will take to go around
    d. a cloud of gas or star that is further from the center will take more time to orbit

26. What of the following statements is part of our best modern theory about how galaxies like ours come to have spiral arms?
    a. spiral arms are caused by chains of black holes which are drawing in a lot of material
    b. spiral arms are places where the density of material is much higher (like a traffic jam)

c. spiral arms are just a coincidence; very few other galaxies have them
d. we have spiral arms because our galaxy is presently merging with another galaxy about our size

27. If I want to find a sizeable collection of Population II stars in the Milky Way Galaxy, where would be a good place to look?
a. near the Sun
b. in a globular cluster high above the Galaxy's disk
c. in the Orion spiral arm
d. on the outer surface of giant molecular clouds

28. How do astronomers measure the mass that the Galaxy contains inside the orbit of the Sun?
a. they count the number of stars one by one and multiply by the average mass of a star
b. they add up all the observations at 21-cm wavelengths (because the mass of hydrogen gas is far greater than the mass in all the stars)
c. they measure the distance to the center of the Galaxy and the period of the Sun's orbit and then use Kepler's Third Law
d. they measure the masses of many other spiral galaxies nearby and then take an average

29. Recently, astronomers have observed stars and other objects that orbit the center of the Milky Way Galaxy farther out than our Sun, but move around *faster* than we do. How do astronomers think such an observation can be explained?
a. all these faster-moving objects must be escaping from the gravity of the Milky Way and will soon be lost to our Galaxy
b. each of the faster-moving outer objects must be the result of a supernova explosion (giving them extra speed)
c. it is the Sun that is moving *too slowly* because of a collision billions of years ago; the outer objects are really moving at the appropriate speed for their distance from the center
d. there must be a great deal of *dark matter* outside the orbit of the Sun whose gravitational pull explains the faster motions we see out there

30. Which of the following statements about dark matter in the Galaxy is FALSE?
a. Most of it cannot at present be observed with our telescopes (we only know its existence from the gravity it exerts)
b. While the dark matter cannot be observed with our present-day instruments, we still have a pretty good idea what it consist of
c. Our measurements suggest that there may be as much as ten times more dark matter in the Galaxy than the matter we *have* been able to observe

d. Dark matter appears to be distributed in a giant corona (outer layer) around the Galaxy

31. The very strong source of radio waves at the center of our Galaxy is called
    a. Sagittarius A
    b. Cygnus X-1
    c. the Crab Nebula
    d. Milky Way CC1

32. Which of the following is NOT part of the chain of evidence that makes many astronomers suspect there is a black hole at the very center of the Milky Way Galaxy?
    a. the motion of stars as close as 5 light days from the center indicates that there is a mass of 2.6 million solar masses inside their orbits
    b. the Hubble Space Telescope has shown us a visible-light image of an accretion disk at the center of the Galaxy
    c. the existence of a strong radio source at the center whose size appears to be no larger than Jupiter's orbit
    d. the fact that Sagittarius A is a stationary radio source, while objects around it appear to be in motion

33. One of the most important observations in the history of astronomy was the one by Edwin Hubble that established that there are *other* galaxies, quite removed from the Milky Way. How did Hubble show this?
    a. by debating with Harlow Shapley and being more eloquent
    b. by observing a supernova explosion in a nearby galaxy, using it as a "standard bulb"
    c. by observing a Cepheid variable in a nearby galaxy and using it to get the distance
    d. by measuring the distances to many globular clusters using parallax

34. Our Milky Way Galaxy is what type of galaxy?
    a. spiral
    b. elliptical
    c. dwarf elliptical
    d. irregular

35. Which type of galaxy is observed to contain mostly older stars?
    a. spiral

b. elliptical
c. barred spiral
d. irregular

36. Which type of galaxy is very difficult to see but (astronomers recently realized) may be very common?
    a. spiral
    b. elliptical
    c. dwarf elliptical
    d. irregular

37. Many irregular galaxies show strange shapes--elongated or chaotic. What explanation do astronomers now believe is responsible for these shapes?
    a. irregular galaxies are born with such fast rotation, they spin apart
    b. irregular galaxies have experienced a huge chain of supernova explosions which have destroyed whatever structure they originally had
    c. irregular galaxies do not have any gas or dust in them, so the stars are free to move in strange orbits
    d. irregular galaxies have experienced or are experiencing collisions or interactions with neighbor galaxies

38. A graduate student in astronomy needs to measure the mass of a spiral galaxy she is studying for her PhD thesis. Which of the following observations would be important for her to make?
    a. determine whether or not there is evidence for a massive black hole at the galaxy's center
    b. construct an H-R diagram for a prominent open cluster in the galaxy's disk
    c. obtain the rotation speed of stars or gas near the outer regions of the galaxy
    d. measure the gamma-ray emission from the galaxy

39. One of the main projects being carried out by the Hubble Space Telescope is to measure the distances of galaxies located in groups dozens of millions of light years away. What method do astronomers use with the Hubble to find such distances?
    a. constructing H-R diagrams
    b. measuring the parallax over a period of a decade or so
    c. finding Cepheid variables and measuring their periods
    d. measuring the x-rays given off by the accretion disks around massive black holes

40. What method would astronomers use to find the distance to a galaxy so far away that individual stars are impossible to make out (resolve)?
    a. parallax
    b. Cepheid variables
    c. using the x-ray emission from the entire galaxy
    d. finding the redshift and using Hubble's Law

41. Which of the following objects is NOT considered useful to astronomers as a "standard bulb" for determining distances?
    a. type I supernovae
    b. planetary nebulae
    c. K-type stars
    d. the brightest supergiant stars in a galaxy

42. The reason type I supernovae are useful to astronomers for determining distances to other galaxies is that
    a. they only occur in spiral galaxies, for which no other way of getting distances is available
    b. it is easy to measure the blueshift produced by such explosions
    c. they are much larger than many other objects that can be seen in galaxies
    d. they are very bright, and generally reach the same peak luminosity

43. If you want to determine the distance of a rich (but very, very distant) cluster of galaxies, which of the following would be an appropriate method to try?
    a. measuring the parallax of a fast-moving member of the cluster
    b. using Cepheid variable stars
    c. measuring the apparent brightness of the brightest elliptical members of the cluster
    d. measuring the apparent size of planetary nebulae in a sample of galaxies

44. The Tully-Fisher method for measuring the distance to galaxies relies on the observed relationship between the luminosity of a spiral galaxy and
    a. its rotational velocity (as determined from the width of the 21-cm line)
    b. its number of high-energy sources (as determined from the total gamma-ray emission)
    c. the size of its supernova remnants (as determined from radio maps)
    d. the number of globular clusters (as determined from high-resolution images)

45. Edwin Hubble was able to show that (with the exception of our nearest neighbors) the farther a galaxy is from us, the
    a. the faster it is moving away from us
    b. brighter it looks
    c. bluer its color
    d. the later in its life we are seeing it

46. The Andromeda Galaxy (our nearest spiral neighbor) has spectral lines that show a blue shift. From this we may conclude that:
    a. the universe is no longer expanding
    b. this particular galaxy is moving toward us
    c. this galaxy has merged with the Milky Way and is now part of it
    d. this particular galaxy is moving away from us

47. According to Hubble's Law, if galaxy B is three times farther away from us as Galaxy A, then Galaxy B will
    a. move toward us three times faster than A
    b. move away from us nine times faster than A
    c. move away from us three times faster than A
    d. move toward us nine times faster than A

48. If quasars often resemble little blue stars, what was it about them that so surprised astronomers when they were discovered?
    a. their surface temperatures were among the lowest measured
    b. they show absolutely no lines in the spectrum
    c. their spectral lines were at first hard to recognize and then turned out to have large redshifts they vary their brightness with a period (time-scale) of seconds
    d. they were all located in globular clusters

49. A distant quasar shows a large redshift--one so large, in fact, that the features we now see in the visible-light region of the spectrum would be *invisible* to us, were it not for the redshift. What band of the electro-magnetic spectrum were these features most likely in, before the spectrum was redshifted?
    a. radio
    b. infrared
    c. ultraviolet
    d. microwaves

50. Today we know that what nearly *all* quasars have in common is that they appear to be small sources of energy with
    a. strong radio emission
    b. variations in luminosity with a period of seconds
    c. redshifts that indicate they are far away
    d. tremendous proper motion (apparent motion across the sky)

51. What method would astronomers use to find the distance to a remote quasar?
    a. parallax
    b. Cepheid variables
    c. using a Type I supernova explosion as a standard "bulb"
    d. finding the redshift and using Hubble's Law

52. After several decades of observation, astronomers have concluded that quasars are
    a. very powerful and compact sources of energy at the centers of distant galaxies
    b. projectiles shot out of our own Galaxy and moving out into intergalactic space
    c. energetic collisions of comets in the Oort Cloud
    d. anti-matter stars in the halo of the Milky Way Galaxy

53. If quasars are at the distances most astronomers believe they are, then (for the most luminous ones) their luminosities must be:
    a. like the Sun
    b. like the combined luminosity of a cluster of a hundred stars
    c. much fainter than the Sun
    d. like the combined luminosity of a hundred trillion (10•…) Suns

54. What makes astronomers believe that the energy source in quasars is only a few light months across (the distance light travels in a few months)?
    a. we have only seen the light from such quasars for a few months so far
    b. a few light months is about the size of a typical galaxy, and astronomers think quasars are active galaxies
    c. quasars show variations in their energy output that have a period of a few months
    d. 10 light months is about the size of the belt of comets around the solar system, and that is where we believe quasars are located

55. Which of the following observations are a clear argument for the idea that quasars are located inside galaxies?
    a. quasars have been discovered in more than one direction in space
    b. quasars appear to be small in angular extent (they look like points)
    c. quasars vary in brightness with time
    d. relatively nearby quasars show "fuzz" around them with the same spectra as stars

56. Which of the following characteristics is NOT shown by Seyfert galaxies?
    a. spiral structure
    b. emission lines in the spectrum of the central region
    c. very bright central regions
    d. tremendous blue shifts

57. Active radio galaxies can display
    a. strong emission from a small central source
    b. long jets of radio emissions
    c. two lobes (regions of radio emission) that can be quite far from the galaxy's center
    d. all of the above

58. Today, astronomers find compelling evidence that the energy source of the quasars and active galaxies is
    a. antimatter and matter colliding at the center of a galaxy
    b. chain reactions of supernova explosions
    c. matter falling toward a supermassive black hole at the center of a galaxy
    d. the left-over (and stored) energy of the big bang explosion

59. The Hubble Space Telescope has enabled astronomers to explore an active galaxy such as M87 in remarkable detail. Which of the following observations of M87 is NOT an important part of the web of evidence that shows it must have a supermassive black hole at the center?
    a. the discovery of a gravitational lens in M87
    b. the discovery that the distribution of stars in the galaxy becomes densely concentrated at the center (much more so than in normal elliptical galaxies)
    c. the discovery of an inner disk of rapidly swirling gas in the center of the galaxy
    d. the Doppler shifts measured for spectral lines coming from rapidly moving gas

60. A friend of yours who is a science fiction fan hears you talk about the fact that astronomers now believe that the mechanism for the large energy output of quasars involves a supermassive black hole. He challenges you, saying something like "Oh come on, every science fiction fan knows that nothing, not even light, can escape from a black hole! How can a black hole be an energy *source*!?" How would you respond to his objection?
    a. you're right, my explanation doesn't make sense; I wonder why astronomers didn't think of that?
    b. light can't escape from the event horizon of a regular black hole; but it can easily escape from the event horizon of a supermassive black hole
    c. it isn't *light* that escapes from the black holes in quasars, but x-rays and gamma-rays, which work by completely different rules
    d. the energy we see from quasars comes from regions where matter is falling in still *outside the event horizon*

61. How do astronomers now explain the fact that the energy emitting regions for quasars are so small?
    a. quasars are just optical illusions caused by gravitational lensing effects
    b. quasars are the result of three or four galaxies colliding: the collision squeezes the quasar to become much smaller than it normally would be
    c. quasars are the result of matter falling into a black hole; the event horizons of black holes are extremely small
    d. quasars are caused by the actions of neutron stars and neutron stars have been squeezed so much that they are very, very small

62. When astronomers make counts of how many quasars there are at different distances from us, what do they find?
    a. there are more quasars closer to us than farther away
    b. the largest number of quasars can be found at about the distance of 1 billion lightyears away from us
    c. the number of quasars is pretty much the same at every range of distances (as many are close to us as far away)
    d. the largest number of quasars can be seen at about the distance corresponding to a time when the universe was only 20% its current age (i. e. when the universe was still young)

63. In the gravitational lenses astronomers have discovered so far, the mass *causing* the lensing effect is usually
    a. a neutron star
    b. a galaxy or galaxy cluster
    c. a very distant quasar

d. the Sun

64. According to the Cosmological Principle, the universe
    a. has no beginning and no end
    b. cannot be understood by the use of scientific observations alone
    c. is isotropic and homogeneous
    d. consists only of galaxies that are exactly like the Milky Way

65. When astronomers say that the groups of galaxies are distributed *isotropically*, they mean that
    a. galaxies are all about the same size
    b. galaxies look the same in all directions
    c. galaxies all have interstellar matter at the same temperature
    d. galaxies all have the same age

66. Roughly how many galaxies make up our Local Group?
    a. only three
    b. a few dozen
    c. hundreds
    d. thousands

67. Which of the following is <u>not</u> true about the Local Group of galaxies (of which the Milky Way is a member)?
    a. it is a member of the same supercluster as the Virgo Cluster
    b. it has few galaxies when compared to a rich cluster
    c. it has more elliptical galaxy members than spiral galaxies
    d. it is found in one of the voids between filaments (soap-bubble walls) of galaxies

68. The rich galaxy cluster that is closest to our Local Group of galaxies is the
    a. Coma Cluster
    b. Hercules Cluster
    c. Virgo Cluster
    d. Ursa Major Cluster

69. According to our current understanding, *giant elliptical galaxies* form:
    a. by being located near the center of the Big Bang explosion and thus getting a major early push
    b. only in the giant voids that astronomers are discovering among the filaments and chains of galaxies
    c. by the merger (or swallowing) of a number of smaller galaxies in a cluster of galaxies
    d. when a black hole swallows enough material so that most of the stars in the galaxy are inside the black hole, leaving only a thin halo

70. The great voids that astronomers are finding are:
    a. regions where a number of black holes have cleared out space in the center of a galaxy
    b. empty regions between the spiral arms of the Milky Way Galaxy
    c. huge HII regions, where the powerful radiation from a hot star has cleared out the local interstellar material
    d. very large regions of intergalactic space, where relatively few galaxies or galaxy clusters can be found

71. Which of the following statements about the relationship between the Local Group and the Local Supercluster is CORRECT?
    a. the Local Group is much larger than the Local Supercluster
    b. the Local Group is on the outskirts of the Local Supercluster
    c. the Local Group is at the center of the Local Supercluster
    d. the Local Group is one of the largest groups of galaxies in the Local Supercluster

72. What do the surveys of the three-dimensional distribution of groups of galaxies reveal about how groups and clusters of galaxies are organized?
    a. galaxy groups are distributed completely evenly--there is typically the same amount of space between them--and so there is no structure evident
    b. galaxy groups make a huge spiral structure that resembles the Milky Way (but is much bigger)
    c. galaxy groups are organized into huge spherical "lumps" with concentric rings of groups of galaxies around each lump
    d. galaxy groups are organized into huge filaments with great voids between them--something like the structure one would see taking a cross-section of some soap bubbles

73. An astronomer is observing a distant galaxy which looks blue. Which of the following can we conclude from this observation?
    a. the galaxy must be moving toward us (must have a blue shift)

b. the galaxy must be extremely large (probably a giant elliptical)
c. the galaxy must have had star formation relatively recently
d. the galaxy must be rotating very slowly or not at all

74. Astronomers can now report that active star formation was going on at a time when the universe was only 10% as old as it is today. When astronomers make such a statement, how can they know what was happening back then?
    a. they look at open clusters in the Milky Way Galaxy
    b. they look at radio emission from active galaxies
    c. they look at the elements in comets, which formed when our solar system was first forming
    d. they examine the spectra of galaxies with the highest redshifts they can find for galaxies

75. When astronomers have examined rich clusters of galaxies with their instruments, they have found that these clusters
    a. contain far more spiral galaxies in their central regions than ellipticals
    b. are often the source of x-rays coming from hot gas that lies between the galaxies
    c. are the only places in the universe where galaxies find a way NOT to collide
    d. contain mostly galaxies dominated by the light of young stars (stars formed recently)

76. Where would you be most likely to find a galaxy that is the result of several "mergers"?
    a. in our Local Group of galaxies
    b. in one of the great voids that our large-scale maps are revealing
    c. in the center of a rich cluster of galaxies
    d. anywhere, as long as it is above or below the plane of the Milky Way

77. Which of the following does NOT happen when two galaxies collide?
    a. large interstellar gas clouds collide
    b. the rate of star formation increases
    c. the shape of the galaxy is often changed
    d. many of the stars in one galaxy collide with the stars in the other

78. An astronomer discovers a massive galaxy which has four nuclei--dense central regions. What is a likely explanation for a galaxy having more than one nucleus?
    a. the nuclei of galaxies often split into two or more parts because of internal activity
    b. the galaxy must have been a quasar earlier in its life

c. the galaxy must have swallowed several smaller galaxies that were its neighbors
d. the galaxy must have had an unusual number of supernova explosions

79. According to the bottom-up model of galaxy formation, the structures that formed first in the universe were about the mass of a(n)
    a. star
    b. large globular cluster
    c. giant elliptical galaxy
    d. supercluster of galaxies

80. Which of the following is the Earth not located in?
    a. the solar system
    b. the universe
    c. the globular cluster M13
    d. the Milky Way Galaxy

81. The expansion of the universe, according to astronomers, is:
    a. a theory for which there is no observational evidence
    b. a piece of established observational evidence which any theory of cosmology must include
    c. a prediction of one theory of cosmology for which the evidence is very controversial
    d. the opposite of what Hubble's Law describes

82. The *Hubble Time* is:
    a. a rough estimate of the age of the universe
    b. the time since the beginning of the solar system
    c. the period it takes for the scale of the universe to double
    d. the length of time a telescope in space can remain in orbit

83. If the Hubble constant turns out to be larger than we have thought in the past, it means that:
    a. the age of the universe is older than we thought
    b. the galaxies are moving apart more slowly than we thought, taking longer to separate
    c. the universe is contracting, not expanding (and it will soon not matter what grade I get on my astronomy final)
    d. the time that has passed since the Big Bang is less than we thought

84. In describing the universe using his equations of general relativity, Einstein assumed that it was isotropic (the same in all directions.) What recent observations have confirmed that the universe is isotropic on the large scale?
    a. the discovery of pulsars
    b. the discovery of cannibal galaxies
    c. measurements of the 3-degree cosmic background radiation
    d. measurements of neutrinos from Supernova 1987A

85. According to our modern theories, the universe (all of space) may be curved or warped in another dimension. This is a pretty bizarre notion; what other discovery in astronomy has helped us believe that space may be able to curve or warp?
    a. supernova explosions and the elements they produce
    b. how the light output of Cepheid variables changes with time
    c. the existence of dwarf elliptical galaxies
    d. black holes

86. In which model (theory) of the universe will all the galaxies eventually show a blue shift in their spectrum instead of a red shift?
    a. the open universe (with negative curvature)
    b. the closed universe (with positive curvature)
    c. a flat universe (with no curvature)
    d. none of the above

87. Which of the following statements about dark matter is FALSE:
    a. it is observed to be a major part of the Milky Way
    b. it is observed to be present in other groups of galaxies
    c. astronomers have a pretty good idea what the dark matter is made of
    d. we can detect its gravity, even though we can't see it

88. Some astronomers searching for what the mysterious "dark matter" might be made of have pinned their hopes on MACHO's (MAssive Compact Halo Objects). What do they think these MACHO's are?
    a. huge concentrations of antimatter, outside of galaxies
    b. vast clouds of neutrinos, emitted by ancient supernovae
    c. black holes, brown dwarfs, and white dwarfs in the regions outside the main disk of our

Galaxy
d. "cannibal galaxies" that have swallowed smaller galaxy neighbors until they have grown very

89. The reciprocal of the Hubble constant (1/H) is a rough measure of:
    a. the period of a typical Cepheid variable
    b. the distance to the last galaxies that formed
    c. the age of the universe
    d. the luminosity of a type I supernova explosion

90. According to the models of the universe that follow from Einstein's theory of relativity, where in the universe did the Big Bang explosion occur:
    a. nowhere; there was no Big Bang in these models
    b. at roughly the location of the Milky Way Galaxy; that is why all the other galaxies are moving away from us
    c. everywhere at the same time
    d. at the location of the Great Attractor

91. According to the models of the universe we discussed in this course, why do the galaxies move apart (why do we have Hubble's law)?
    a. there is a repulsive force in the universe (given by the cosmological constant) that pushes everything apart
    b. each galaxy has net charge on it, and they repel by the laws of electricity
    c. supernova explosions happen more frequently on one side of each galaxy, giving the entire galaxy a push that moves it away from its neighbors
    d. as a result of the Big Bang, space itself is stretching, and this stretching carries the galaxies away from each other

92. In the closed model of the universe, the universe ends with:
    a. a Big Crunch
    b. a gradual cooling, thinning, and darkening of the contents of the universe
    c. a sudden cold freeze that will halt all motion
    d. the galaxies expanding faster and faster

93. In a flat universe (where the density equals the critical density), the curvature of the universe:

a. is positive
b. is zero
c. is negative
d. is the largest of any theory