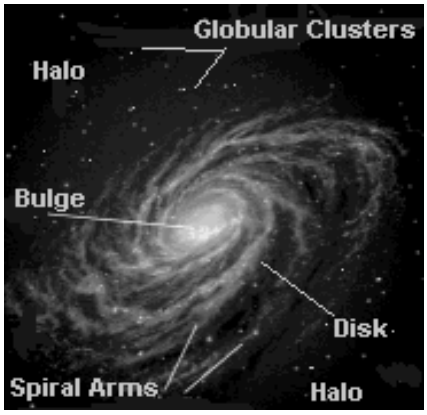
Astronomy 101 U & V **Name _____**
Spring 2000
Exam #3 -- Version A **Student No. _____Section _____**

1. **What is a star?**
   a) A large, glowing ball of gas that generates energy through nuclear fusion in its core.
   b) A large, glowing ball of gas that generates energy through nuclear fusion in its core.
   c) A large, glowing ball of gas that generates energy through nuclear fusion in its core.
   d) A large, glowing ball of gas that generates energy through nuclear fusion in its core.
   e) All of the Above

2. **A major discovery made by Harlow Shapley using RR Lyrae stars and globular clusters established**
   a) that the spiral nebulae (galaxies) are actually far beyond the milky way.
   b) that the halo has mostly low-mass, cool, old stars.
   c) the size of the Galaxy and the Sun's position in it.
   d) that globular clusters lie outside the Milky Way at large distances.
   e) All of the above.



3. **Where is active star formation most often found in the Galaxy?**
   a) In the halo
   b) Throughout the disk
   c) Galactic bulge
   d) In spiral arms
   e) All of the above.

4. **What kinds of objects lie in the halo of our galaxy?**
   a) globular clusters
   b) gas and dust
   c) open clusters
   d) O and B stars
   e) All of the above

5. **What kinds of objects lie in the disk of our galaxy?**
   a) open clusters
   b) old K and M stars
   c) gas and dust
   d) O and B stars
   e) All of the above

6. **We believe 90% of the mass of the Milky Way is in the form of non-luminous matter because**
   a) We see dark blotches in the night sky, and we believe these blotches are dark matter located in the halo.
   b) Dark matter **can** be seen with radio wavelengths, and such observations confirm that the halo is full of this material.
   c) N-body simulations (as seen in the video shown in class) suggest that a galaxy cannot form unless it has at least 10 times as much matter as in the Milky Way disk, suggesting that the halo is full of dark matter.
   d) The orbital speeds of stars far from the galactic center do not follow Kepler's Laws, suggesting that these stars are feeling gravitational effects from unseen matter in the halo.
   e) Trick question, as recent observations have shown that there is not that much dark matter hidden in our Milky Way, only in large galaxy superclusters.

7. **Compared with stars in the disk, orbits of stars in the halo of our galaxy**
   a) are ellipses with no overall ordered direction.
   b) depend on their distances from the plane of the Galaxy.
   c) are elliptical and generally in the same overall direction.
   d) do not have to be around the galactic center.
   e) do not have to pass through the plane of the galaxy.

8. **What produces the 21-cm line that we use to map out the Milky Way Galaxy?**
   a) the electron "flip" in atomic hydrogen
   b) rotational-vibrational energy of molecular hydrogen
   c) ionized hydrogen recapturing an electron
   d) excited helium
   e) carbon monoxide de-excitation

9. **What events may trigger new star formation in a spiral arm?**
   a) Compression from a density wave
   b) Shock waves from emission nebulae
   c) Shock waves from supernovae
   d) All of these

10. **Where are most heavy elements made?**
   a) in the cores of stars and supernovae explosions
   b) in the interstellar medium during spiral arm compression
   c) moments after the Big Bang, as the temperature cooled to 10 million degrees K.
   d) in shock waves of planetary nebulae
   e) all of the above

11. **What evidence supports the theory that there is a black hole at the center of our galaxy?**
   a) We see gas falling onto an accretion disk and central mass at the center of our galaxy.
   b) The motions of the gas and stars at the center indicate that it contains a million solar masses within a region only about 1 parsec across.
   c) We observe an extremely bright gamma-ray source at the very center of our galaxy.
   d) We observe a large, dark object that absorbs all light at the center of our galaxy.
   e) All of the above provide evidence of a supermassive black hole.

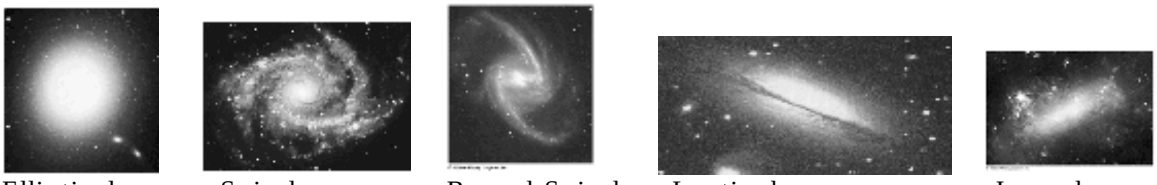
12. **Based on the idea of chemical enrichment, which types of stars must contain a higher proportion of heavy elements?**
   a) Stars in globular clusters.
   b) Rogue stars far out in the halo.
   c) Old K- and M-type stars of the disk.
   d) Stars in open clusters like the Pleiades that have young stars.
   e) Stars formed when the Milky Way first collapsed.

13. **What perception of the Milky Way Galaxy did astronomers have in the early part of this century?**
   a) They believed that the Earth rested inside concentric spheres, with the Milky Way stars fixed to the outermost sphere.
   b) They believed that the Milky Way was on one of billions of galaxies in the Universe.
   c) They believed that the Milky Way was the entire Universe.
   d) They believed that, because the Sun was at the center of the Milky Way, it was impossible to see the rest of the Universe.
   e) They believed that there was too much dust to determine much at all.

14. **The location of the center of the Galaxy is determined by observations of**
   a) the period-luminosity relationship of Cepheid variables
   b) RR Lyrae stars in Globular Clusters
   c) massive O and B stars in the spiral arms
   d) a visually bright massive object around which all objects in the Galaxy move.
   e) the distribution of dark matter in the halo.

15. **Which is the correct description of the Sun's location within the Milky Way?**
   a) At the outer edge of the galactic bulge but in the plane of the disk.
   b) In the disk, but at its very outer edge, in the Orion arm.
   c) Above the disk and about 1/3 the of the galactic radius from the center.
   d) In the disk and about 2/3 of a galactic radius from the center.
   e) In the middle of the Sagittarius Arm, where it orbits every 100 million years.

16. **The object located at the center of the Galaxy is believed to be a(n)**
   a) large cluster of stars
   b) enormous emission nebula
   c) supermassive black hole
   d) inactive quasar
   e) massive star-forming region


Elliptical Spiral Barred Spiral Lenticular Irregular

Galaxies Not to Scale

17. **Which of the following properties of elliptical galaxies is also shared with spiral galaxies?**
   a) No significant gas or dust
   b) Lack of a defined disk
   c) Contains old K- and M-type stars
   d) Large range in sizes and numbers of stars
   e) Elliptical galaxies and spirals have no properties in common.

18. **What property is common to almost all spiral galaxies**
   a) Ongoing star formation
   b) The disk, bulge, and halo
   c) Abundant interstellar gas
   d) All of the above

19. **A galaxy is at a distance of one billion light years. Which of the following is true?**
   a) We see the galaxy the way it will be in one billion years.
   b) We see the galaxy the way it was one billion years ago.
   c) We see the galaxy the way it was when the Universe was one billion years old.
   d) We see what our galaxy will be like in one billion years.

20. **Why are supermassive elliptical galaxies often found at the cores of rich galaxy clusters?**
   a) Due to gravity, most of the matter forming the cluster fell into the center.
   b) Such a large galaxy attracted smaller galaxies around it to form a cluster.
   c) Large galaxies, passing a cluster, get captured into the center.
   d) They are the result of numerous galactic mergers--cannibalism on the largest scale.

21. **An astronomer needs to measure the distance to a globular cluster of stars that is part of the Milky Way. What method should she try to use?**

a) measure the spectroscopic parallax of the cluster.
b) count the number of O and B type stars in the cluster.
c) look for flickering x-rays coming from black holes in binary systems
d) measure the redshifts of the stars in the cluster
e) find an RR Lyrae variable star in the cluster.

22. **Our Milky Way galaxy is what type of galaxy?**
a) elliptical (E0-E3)
b) dwarf elliptical (most common type in local group)
c) spiral (barred spiral)
d) irregular, much like the Large Magellanic Cloud
e) none of the above

23. **Where should we look for the youngest stars in a spiral galaxy?**
a) in the halo, near globular clusters.
b) wherever there is dark matter, as dark matter seeds star formation
c) in the spiral arms of the disk where the density is greater
d) in the nucleus of the galaxy, near the accretion disk
e) statistically, in all parts of the galaxy.

24. **Which of the following types of galaxies are most spherical in shape**?
a) irregulars
b) spirals
c) lenticulars
d) ellipticals

25. **Which of the following types of galaxies are reddest in color?**
a) spirals
b) lenticulars
c) ellipticals
d) irregulars
e) those with the largest redshifts

26. **One of the most important observations in the history of astronomy was the one made by Edwin Hubble (about 1920) that established that there are other galaxies, quite removed from the Milky Way. How did Hubble show this?**
a) By winning the debate with Drs. Shapley, Curtis, and Einstein.
b) By observing a supernova explosion in a nearby galaxy, using it as a "standard candle."
c) By observing a Cepheid variable in the Andromeda galaxy and calculating the distance.
d) By measuring the distances to many globular clusters using RR Lyrae variables.

27. **Which type of galaxy is observed to contain <u>almost all</u> old stars?**
a) Spiral
b) Elliptical
c) Irregular
d) All of the above contain mostly old stars.

28. **Hubble's law relates which two observed properties of a galaxy?**
a) Rotation and luminosity
b) Distance and recessional velocity
c) Peak luminosity and distance
d) Mass and luminosity

29. **Once Hubble's law is established, what single observation is needed of a galaxy in order to determine its distance?**
a) Luminosity
b) Line broadening

c) Mass contained in dark matter
d) Recessional velocity
e) Rotation velocity

30. **How does the age of the Universe depend on the Hubble constant?**
a) It is proportional to it.
b) It depends on the square of it.
c) It is inversely proportional to it.
d) It is proportional to the inverse square of it.

31. **Which of the following is the correct interpretation of the Hubble law?**
a) As galaxies move outward, they are replaced with new matter created to take its place.
b) The farther away a galaxy is, the faster it is moving away, because of the big bang.
c) Galaxies are not moving through space, it is space that is expanding over time.
d) Galaxies are stationary but time continues to change, giving the appearance of motion.

32. **Because we see the light from distant galaxies redshifted, we know that**
a) we are at the center of the Universe.
b) the Universe is expanding.
c) the sky must be filled with galaxies.
d) all of the above.

33. **The redshift of galaxies in the Universe is correctly interpreted as**
a) a Doppler shift due to the motions of the galaxies through space.
b) an "aging" of the light.
c) space itself expanding with time, stretching the wavelengths from the light
d) the difference in temperatures of distant and nearby galaxies.

34. **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

35. **Which of the following statements about the implications of Hubble's Law is <u>FALSE</u>?**
a) The law implies that the whole Universe must be expanding.
b) If we can measure the redshift of a galaxy, we can determine its distance.
c) The law requires that we (at 0,0) be at the center of the expanding Universe.
d) If you were observing the Universe from a distant galaxy, you would see galaxies moving away from you.
e) Although space is expanding, the galaxies themselves are not expanding in size.

36. **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 age of the Universe is younger than we thought.
c) the galaxies are moving apart more slowly than we thought.
d) the time that has passed since the Big Bang is greater than we thought.
e) None of the above.

37. **Suppose that we look at a photograph of many galaxies. Assuming that all galaxies formed at about the same time, which galaxy in the picture is the youngest?**
a) the one that is closest to us
b) the one that is reddest in color
c) the one that is farthest away
d) the one that appears smallest in size

38. **Which types of galaxies have a clearly defined disk component?**
   a) spirals only
   b) irregulars only
   c) ellipticals only
   d) lenticulars only
   e) spirals and lenticulars

39. **What is the *major* difference between an elliptical galaxy and a spiral galaxy?**
   a) Elliptical galaxies are not as big as spiral galaxies.
   b) An elliptical galaxy lacks a disk component.
   c) A spiral galaxy contains mostly younger stars.
   d) There are no dwarf spiral galaxies, but there are dwarf ellipticals.
   e) A spiral galaxy has a spherical halo.

40. **What is a standard candle?**
   a) any astronomical object for which we know the exact apparent brightness
   b) an object for which we are likely to know the true luminosity
   c) stars in the field of a variable star; used to determine the relative apparent brightness
   d) a class of objects in astronomy that all have exactly the same apparent magnitude
   e) an object for which we can easily measure the apparent brightness

41. **What is the primary practical difficulty that limits the use of Hubble's law for measuring distances?**
   a) We do not know Hubble's constant very accurately yet.
   b) Redshifts of galaxies are difficult to measure using current technology.
   c) The motion of the solar system relative to the Local Group is difficult to account for.
   d) Hubble's law is only useful theoretically; it is difficult to use in practice.
   e) The recession velocities of distant galaxies are thought to approach infinity.

42. **Dr. Drew believes that the Hubble constant is 50 km/s/Mpc. Dr. Ruth believes it is 100 km/s/Mpc. Which statement below automatically follows?**
   a) Dr. Drew believes that the Universe is older than Dr. Ruth believes.
   b) Dr. Drew believes that the Universe has a much lower density than Dr. Ruth believes.
   c) Dr. Drew believes that the Universe is younger than Dr. Ruth believes.
   d) Dr. Drew believes that members of our Local Group are moving away from us; Dr. Ruth does not.
   e) Dr. Drew believes that the Universe is accelerating; Dr. Ruth does not.

43. **Dr. Ackroid believes that the Hubble constant is 100 km/s/Mpc. Dr. Curtain believes it is 50 km/s/Mpc. Which statement below automatically follows?**
   a) Dr. Ackroid believes that the Universe is younger than Dr. Curtain believes.
   b) Dr. Ackroid believes that members of our Local Group are moving away from us; Dr. Curtain does not.
   c) Dr. Ackroid believes that the Universe is expanding, but Dr. Curtain does not.
   d) Dr. Ackroid believes that the Universe older than Dr. Curtain believes.
   e) Dr. Ackroid believes that Dr. Curtain is a poor, ignorant slut.

44. **How do observations of distant galaxies help us learn about galaxy evolution?**
   a) We can observe the evolution of a single galaxy over time using the Hubble Telescope.
   b) We can observe two galaxies merging, helping us learn how mergers affect evolution.
   c) We can observe the birth of galaxies as we look-back to the edge of the Universe.
   d) We can see what our galaxy used to look like and therefore theorize about the physical processes that led to its current appearance.
   e) Observations at different distances show galaxies of different ages and therefore different stages of evolution.

45. **What is a quasar?**
   a) a star-like object that actually represents a bright patch of gas in the Milky Way
   b) a specialized astronomical telescope, used exclusively for observing distant galaxies
   c) the extremely bright center of a distant galaxy, thought to be powered by a massive black hole
   d) another name for very bright stars of spectral type O and B, found in spiral arms
   e) a very large galaxy thought to be formed by the merger of several smaller galaxies, typically found in the center of a galaxy cluster

46. **The most active galactic nuclei are usually found at large distances from us; relatively few nearby galaxies have active galactic nuclei. What does this imply?**
   a) Active galactic nuclei can form only at large distances from the Milky Way.
   b) Active galactic nuclei tend to become more and more active as they age.
   c) Massive black holes existed only when the Universe was young and then died.
   d) The jets seen in many active galactic nuclei must cause them to move far away from us.
   e) None of the above.

47. **Why should galaxy collisions have been more common in the past than they are today?**
   a) Galaxies were more active in the past and therefore would have collided more often.
   b) Galaxies were closer together in the past because the Universe was smaller.
   c) Galaxies were much bigger in the past since they had not contracted completely.
   d) 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.
   e) Galaxy collisions shouldn't have been more common in the past than they are now.

48. **What evidence supports the idea that a collision between two spiral galaxies might lead to the creation of a single elliptical galaxy?**
   a) the fact that elliptical galaxies dominate the galaxy populations at the cores of dense clusters of galaxies
   b) observations of giant elliptical galaxies at the center of dense clusters that may have grown by consuming other galaxies
   c) observations of some elliptical galaxies surrounded by shells of stars that probably formed from stars stripped out of smaller galaxies
   d) observations of some elliptical galaxies with stars and gas clouds in their cores that orbit differently from the other stars in the galaxy
   e) all of the above

49. **Why isn't space expanding within systems such as our solar system or the Milky Way?**
   a) We are so close to these systems that the expansion is too small to measure.
   b) The Universe is not old enough yet for these objects to begin their expansion.
   c) Hubble's law of expansion applies only to the vacuum of space between galaxies.
   d) Their gravity is strong enough to hold them together against the expansion of the Universe.
   e) Both **c** and **d** are correct.

50. **What are peculiar velocities?**
   a) velocities directly along our line of sight (also called radial velocities)
   b) velocities of distant objects that are caused by the gravitational interaction of objects.
   c) velocities that are an indirect result of the expansion of the Universe
   d) velocities that we cannot explain by either the gravitational or electromagnetic force
   e) velocities perpendicular (across or tangential) to our line of sight

51. **What do we mean when we say that the Universe is expanding?**
   a) Individual galaxies are gradually growing in size as they evolve.
   b) Average distances are increasing between star systems within galaxies.
   c) Space is expanding, carrying the galaxies with it.
   d) Everything in the Universe is gradually growing in size.
   e) All of the above.

52. **The Earth is made mostly of metals and rocks. Where did this material come from?**
   a) It was produced by nuclear fusion in stars.
   b) It was produced in the Big Bang.
   c) It was created by chemical reactions in interstellar space.
   d) It was made by our Sun.
   e) It was produced by nuclear fission in nuclear plants on Earth.

53. **How are galaxies important to our existence?**
   a) Without galaxies, the Universe could not be expanding.
   b) Without galaxies, there could not have been a Big Bang.
   c) Galaxies prevent planets from leaving their orbits around stars (i.e., Earth and Sun).
   d) Galaxies provide the overall gravity that prevents us from falling off the Earth.
   e) Galaxies recycle heavy elements produced in stars into future generations of stars.

54. **Where did the big bang occur?**
   a) Here
   b) There
   c) Everywhere
   d) At what we now call the edge of the Universe
   e) At the locations of the quasars

55. **What is the origin of the cosmic microwave background?**
   a) Light from the big bang, produced during “decoupling” of matter and radiation.
   b) The combined radiation of all objects too distant to see individually
   c) The light from billions and billions of stars in the Universe
   d) The total of all the synchrotron sources surrounding supermassive black holes.
   e) All of the above.

56. **By the end of the nuclear epoch, some 1000 seconds after the big bang, the matter of the Universe was composed of 25 percent ____ .**
   a) Hydrogen
   b) Helium
   c) Deuterium
   d) Carbon

57. **What purpose or role was played by dark matter in the early Universe?**
   a) It gave rise to the period of inflation where the Universe expanded by 52 powers of ten.
   b) Dark matter annihilation in the early Universe produced the background radiation.
   c) It limited the nucleosynthesis of heavy elements during the big bang.
   d) Its density fluctuations determined the overall large-scale structure of the Universe.

58. **What type of spectrum is the cosmic microwave background?**
   a) Thermal radiation

b) Emission line
c) Absorption line
d) Synchrotron
e) Discontinuous

59. **The look-back time of an object is directly related to its**
a) distance.
b) variability.
c) luminosity.
d) angular size.

60. **The cosmic microwave background is important mostly because**
a) its detection represented a major technological advance.
b) it confirmed a major prediction made by the Big Bang theory.
c) it showed that the Universe is open and accelerating.
d) it showed that the Universe is closed and decelerating.

61. **Why didn't an abundance of elements heavier than helium form in the early Universe?**
a) The expansion cause the temperature and density to drop too low for fusion to occur.
b) Heavier elements did form, but didn't survive subsequent massive star formation.
c) The laws of physics prohibit the formation of elements heavier than helium, except in stars
d) A combination of all of the above.

62. **What is "entropy"?**
a) Another word for the "strong force" that holds a nucleus together.
b) a measure of disorder within a physical system--whenever entropy is generated, the amount of disorder increases
c) A synonym for gravity, only used in a broader sense in the expanding Universe
d) The tendency of objects in the Universe to become more ordered; for example, the increasing intelligence of humankind
e) None of the above

63. **Which of the following has your "address" in the correct order?**
a) you, Earth, solar system, Local Group, Milky Way, Local Supercluster
b) you, Earth, solar system, Local Group, Local Supercluster, Milky Way
c) you, Earth, Local Group, Local Supercluster, solar system, Milky Way
d) you, Earth, solar system, Milky Way, Local Group, Local Supercluster
e) you, Earth, solar system, Milky Way, Local Supercluster, Local Group

64. **Why did Carl Sagan say that we are star stuff?**
a) Cosmic rays reaching the Earth from distant astronomical sources may be one source of mutations that help evolution along.
b) The composition of most stars (mostly hydrogen and helium) is about the same as the composition of our bodies.
c) Nearly every atom from which we are made once (before the solar system formed) was inside of a star.
d) Sagan thought that all of us have the potential to be movie (or TV) stars like he was.
e) Nearly every atom from which we are made was once inside our star, the Sun.

EQUATIONS ARE ON THE BACK PAGE

Make sure that your name, students number, section, and test version are noted on your scantron, including the bubbles. The exam 3 scores should be available Thursday; quarter grades will be available on Monday morning, June 12.

Have an excellent summer.

EQUATIONS

Magnitude Equation: $m - M = 5\log d - 5$

Hubble's Law: $v = H_o d$

Small angle (distance) formula: $distance = \frac{\text{actual size}}{\text{angular size}}$

Age of the Universe: $t = \frac{1}{H_o}$

Force of Gravity: $F = G\frac{mM}{d^2}$

A completely scientific vote on the fate of the Universe:

◊ Eventual halt, followed by "Big Crunch"

◊ Eventual halt and stand-still

◊ Continued slow expansion

◊ Acceleration and final victory of "entropy"

◊ Other _____