ASTRONOMY 0089: EXAM 3
Class Meets M,W,F, 1:00 PM
April 19, 1996

**INSTRUCTIONS:** First fill in your name and social security number (both by printing and by darkening the correct circles). Sign your answer sheet using your normal signature. Now answer all 46 questions. Students should choose the best answer of those given. There is only one correct answer for each question. Read all questions carefully before answering.

1. Olber's paradox refers to the fact that all observers, no matter where they are located, see other galaxies moving away from them.

   a. True
   b. False

2. The numerous absorption lines seen in the spectra of some quasars are thought to arise through absorption by intervening gas between us and the quasar.

   a. True
   b. False

3. Which statement regarding galaxies is INCORRECT.

   a. Galaxies are known to contain dark matter because of the gravitational influence of the dark matter on luminous matter.
   b. Galaxies are a collection of stars. Each star is confined to the galaxy because of the gravitational influence of all the other stars.
   c. The 4 main types of galaxies are elliptical, SO, spiral, and irregular.
   d. Galaxies tend to reside in groups.
   e. Hubble's tuning fork diagram of galaxies illustrates the evolution of galaxies.

4. Which statement regarding spiral galaxies is INCORRECT?

   a. They contain both young and old stars.
   b. They show a net rotation.
   c. They contain a significant amount of gas and dust.
   d. Their mass-to-light ratios are generally lower than that of elliptical galaxies.
   e. Old stars delineate the spiral arms.

5. Open clusters are dense spherical groupings of Population II stars.

   a. True
   b. False

6. Clusters of stars are useful for testing stellar evolution because

   a. all stars in a cluster have approximately the same age.
   b. all stars in a cluster have approximately the same chemical composition.
   c. all stars in a cluster have approximately the same distance from Earth.
   d. it easy to constrain the cluster age by determining the types of stars that are present in the cluster.
   e. for all of the above reasons.

7. The radius of a 1 solar mass white dwarf is approximately

   a. 10 km
   b. the radius of the Earth.
   c. the radius of the Sun.
   d. the width of Australia.
   e. 0.1 times the radius of the Sun.

8. Two stars, at the same distance from Earth, show IDENTICAL stellar features in their spectra. One object, however, is fainter and has a redder spectrum (i.e. more energy is emitted in the red relative to the blue spectral region) than the other. Which of the following is the most likely explanation for the difference in the two stars?

   a. They are the same star — we see two stars because of an intervening gravitational lens.
   b. Between the Earth and the fainter star there is a cloud of gas and dust which is absorbing and scattering some of the light coming from the star.
   c. The fainter star has a lower temperature, and hence its luminosity is less. As its temperature is lower, it is also redder.
   d. The fainter star has a small radius, and hence its luminosity is less.
   e. One star is population I, and the other is population II.

9. The properties of a black hole depend on the chemical composition of the star from which it was created.

   a. True
   b. False

10. Which of the following best describes Novae?

   a. They are young stars in the process of forming.
   b. They occur in binary systems containing a Neutron star which is accreting material from the companion star.
   c. They are the final evolutionary stage of the most massive stars.
   d. It is a star which brightens rapidly (within a few days) by a factor of 100 to 1 million. The brightening is believed to be caused by nuclear reactions in accreted material on the surface of a White Dwarf star.
   e. An evolved single star entering the red giant phase of its evolution.

11. A quasar

a. is an interacting binary containing a neutron star and a main sequence star.
b. is an interacting binary containing a neutron star and a white dwarf star.
c. is a nearby class of galaxy.
d. is an extremely distant and luminous object which can emit 100 times more luminosity than the entire Milky Way Galaxy from a volume no bigger than our Solar system.
e. probably generates its energy from the fusion of hydrogen into helium.

12. The Chandresekhar mass is believed to be approximately

a. 10 $M_{sun}$.
b. 5 $M_{sun}$.
c. 0.08 $M_{sun}$.
d. 1.4 $M_{sun}$.
e. 3.0 $M_{sun}$.

13. A reflection nebula is a cloud of gas and dust which scatters light from a nearby star towards the Earth. The spectrum is similar to that of the star, but bluer in color.

a. True
b. False

14. The radius of the event horizon of a 3 $M_{sun}$ black hole is approximately 9 km. What is the radius of the event horizon for a black hole with a mass of 27 $M_{sun}$?

a. 27 km
b. 243 km
c. 81 km
d. 1 km
e. 3 km

15. A compelling argument against the Steady State theory is that observations of distant galaxies and quasars reveal that the Universe is evolving (i.e., it is changing with time.)

a. True
b. False

16. Massive elliptical galaxies typically have a mass-to-light ratio of 100. Astronomers have just found a distant elliptical galaxy, and have determined from observations that its Luminosity is $10^{11} L_{sun}$. What is a reasonable estimate of the galaxy's mass?

a. $10^{13} M_{sun}$
b. $10^{11} M_{sun}$
c. $10^{12} M_{sun}$
d. $10^{10} M_{sun}$
e. $10^{9} M_{sun}$

17. Two quasars are observed to lie near each other (within a few arcseconds) on the sky. The objects have identical spectra (and hence redshifts) and colors. Photometric monitoring of the quasars reveals that both quasars fluctuate in brightness in the same way. Which of the following statements is likely to apply?

a. The two quasars are distinct objects, and occur close together in the sky only by chance.
b. The two quasars are most likely images of the same quasar produced by a gravitational lens between us and the quasar.
c. They are components of a binary quasar. Since both quasars formed at the same time they look the same.
d. They are actually nearby stars that have been mistaken for quasars because of their stellar appearance.
e. They are the same quasar, but two images arise from the effects of interstellar extinction.

18. A rotation curve refers to a plot of the rotation velocity of objects in a galaxy against their distance from the center of that galaxy.

a. True
b. False

19. In a HII region

a. hydrogen is mainly neutral.
b. hydrogen is mainly in the form $H_2$.
c. the temperature is about 100K.
d. hydrogen is mainly ionized.
e. none of the above.

20. We believe the Milky Way is a spiral galaxy because

a. we can see the spiral arms reflected in distant dust clouds.
b. of the way the rotation velocity of the stars changes with distance from the galactic center.
c. radio observations of interstellar clouds show they lie in spiral arms.
d. x-ray photographs show that red giants are bunched into spiral patterns.
e. of the distribution of globular clusters.

21. The big bang is currently the preferred model (theory) to describe our Universe because

a. it provides a simple explanation for the microwave background radiation.
b. it provides a simple explanation for the observed expansion of the Universe.
c. it predicts the correct abundance of H and He in the Early Universe.
d. it provides a simple explanation for the observed changes in the Universe as we look back in time.
e. all of the above.

22. Observations of the microwave background radiation are important as

a. they may allow the determination of how nucleosynthesis proceeded in the early Universe.
b. they allow us to see back to a time when the Universe had a temperature of millions of degrees.
c. they allow a determination of the structure of the Milky Way galaxy.
d. they may allow the detection of inhomogeneities in the early Universe that may represent the seeds of galaxy formation.
e. they may allow a determination of the structure of the local group of galaxies.

23. Which statement about Population I and Population II stars in our galaxy is INCORRECT?

a. Population I stars are found primarily in the disk of our galaxy.
b. Population II stars are generally found in the halo of our galaxy — they are not confined to the disk.
c. Population I objects have an abundance of metals (e.g., C, N, O, Fe) similar to that of the Sun.
d. Population II objects have an abundance of metals (e.g., C, N, O, Fe) significantly lower than that of the Sun.
e. Population II stars are young stars — younger or similar in age to the Sun.

24. The 3 K background radiation is believed to be a relic of the Big Bang when it had a temperature of about 3000 K. The background now has a temperature of 3 K due to the expansion of the Universe.

a. True
b. False

25. HI emission, also known as 21cm emission, arises from

a. HII regions.
b. neutral hydrogen. The emission occurs when the electron makes a transition from spinning in the opposite direction as the nucleus, to spinning in the same direction.
c. a change in the rotational energy of molecular hydrogen.
d. ionized hydrogen atoms.
e. neutral hydrogen. The emission occurs when the electron makes a transition from spinning in the same direction as the nucleus, to spinning in the opposite direction.

26. Brown dwarfs, stellar remnants, neutrinos and exotic particles have all been suggested to be possible components of the dark matter that exists in our galaxy, and in the Universe.

a. True
b. False

27. Which of the following best describes the scattering of light by an interstellar dust particle?

a. The photon is absorbed by the dust particle.
b. When a photon strikes a dust particle, its direction of travel is altered. Its frequency and hence its energy remains the same.
c. When a photon strikes a dust particle, its direction of travel is altered. As a consequence of the scattering the photon loses a significant amount of energy, and is made redder.
d. When a photon strikes a dust particle, its direction of travel is altered. As a consequence of the scattering the photon gains a significant amount of energy, and is made bluer.
e. The photon ionizes the H associated with the dust particle.

28. Light emitted from the surface of a white dwarf star suffers a blue shift (i.e., features are shifted to shorter wavelengths) due to the strong gravitational field of the white dwarf.

a. True
b. False

29. A neutron star is composed primarily of

a. neutrinos.
b. iron.
c. neutrons.
d. protons, electrons, and neutrons.
e. iron

30. Which of the following is NOT a constituent of our galaxy, the Milky Way.

a. Reflection nebulae
b. Dark matter
c. Globular clusters
d. Dust
e. Quasars

31. A particular quasar is observed to vary (by a factor of 2) on a time scale of 1 week. No faster variations are seen. Which statement is correct?

a. Without direct imaging of the central source we have no information about the size of the quasar.
b. The minimum size of the quasar is approximately 7 light days. (i.e. the distance light travels in 7 days).
c. The maximum size of the quasar is approximately 7 light days
d. The minimum size of the quasar is approximately 49 light days.
e. The maximum size of the quasar is approximately 49 light days.

32. Observations of the cosmic background radiation show it to be slightly brighter in one quarter of the sky than in the opposite quarter of the sky. This brightening is due to

a. galaxy formation.
b. star formation.
c. background radiation from the central regions of the Milky Way Galaxy.
d. poor instrumental calibration.
e. the motion of the Sun through the Universe.

33. The Milky Way Galaxy is an example of an irregular galaxy.

a. True
b. False

34. Which statement regarding elliptical galaxies is INCORRECT?

a. They contain mainly old stars.
b. They show little global rotation.
c. About 10% of their mass is gas and dust.
d. The are spherical or ellipsoidal in shape.
e. They may have formed through the merger of smaller galaxies.

35. The pulses seen from a Pulsar are due to

a. the change in brightness caused by the periodic contraction and expansion of the neutron star.
b. a dark companion periodically eclipses the neutron star.
c. the neutron stars rapid rotation which sweeps beams of radiation across the viewer's line of sight.
d. blobs of hot gas falling rhythmically onto the Neutron star's surface.
e. a rotating white dwarf emitting short bursts of energy.

36. A galaxy in the local group is observed to be APPROACHING us with a velocity of 500 km/s. Which of the following statements regarding the nature of this velocity is correct?

a. Since the galaxy is approaching us, Hubble's law must be incorrect, and we will not be able to apply it to distant galaxies.
b. It is extremely difficult in Astronomy to measure reliable velocities. As the object is moving towards us, it is most probable that the deduced velocity is in error.
c. Local group galaxies are strongly affected by the gravitational influence of other local group galaxies. As a consequence the local group does not partake in the overall expansion of the Universe.
d. The density of the universe exceeds the critical value, and as a consequence the Universe has reversed its expansion, and is now collapsing.
e. The density of the universe is lower than the critical value, and as a consequence the Universe has reversed its expansion, and is now collapsing.

37. Globular clusters in the Milky Way

a. are composed of Population I and II stars.
b. have no regular shape.
c. are confined to the disk of our galaxy.
d. are composed of Population II stars only.
e. each contain about 1 billion stars.

38. Suppose Q, of "Star Trek: The Next Generation", turned the Sun into a black hole, but otherwise left the rest of the solar system unchanged. Which statement is true?

a. The gravitational force exerted by the Sun on the Earth would remain unchanged.
b. The gravitational force exerted by the Sun on the Earth would decrease.
c. The gravitational force exerted by the Sun on the Earth would increase, but the Earth would remain in a stable orbit.
d. The Earth would begin to spiral rapidly into the black hole.
e. Due to the intense gravitational pull of the black hole, humans leaving the Earth (assuming they could survive without a luminous Sun) would spiral in towards the Black Hole.

39. The approximate age of our Universe is

a. $4.5 \times 10^8$ years.
b. $10^8$ years.
c. $1.5 \times 10^{10}$ years.
d. $4.5 \times 10^9$ years.
e. $10^{12}$ years.

40. If an alien in a distant galaxy looks at the galaxies it can see it will observe that

a. other galaxies are moving towards it.
b. other galaxies are stationary.
c. other galaxies are moving away from it.
d. about half the galaxies are moving towards it, and about half away from it.
e. none of the above.

41. The evolution and ultimate fate of our Universe is determined by

a. its density.
b. its mass.
c. its composition.
d. the nature of the microwave background radiation.
e. the evolution of galaxies.

42. The Chandresekhar mass refers to

a. The maximum mass of a white dwarf star.
b. The maximum mass of a neutron star.
c. The minimum mass of a white dwarf star.
d. The minimum mass of a neutron star.
e. The minimum mass of a black hole.

43. Which statement about our universe is correct?

a. Observations suggest that the universe is "open" and as a consequence it will continue to expand forever.
b. Observations suggest that the universe is "open" and as a consequence it will halt its expansion and begin to collapse.
c. Observations suggest that the universe is "closed" and as a consequence it will continue to expand forever.
d. Observations suggest that the universe is "flat". The 2D analogue of such a universe is the surface of a plane.
e. The universe contains little, if any, dark matter.

44. The event horizon refers to the radius of the singularity at the center of a black hole.

a. True
b. False

45. If Hubble's constant is 100 km/s/Mpc, what is the distance of a galaxy which is observed to be moving away from us with an observed velocity of 20,000 km/s?

a. 20 Mpc
b. 200 Mpc
c. 50 Mpc
d. 40 Mpc
e. 2000 Mpc

46. Which statement about the mass of our Galaxy is correct?

a. The mass of the **ENTIRE** Milky Way Galaxy can be determined by applying the modified form of Kepler's 3rd law to the motion of the Sun about the center of our galaxy.
b. The mass of the Milky Way Galaxy **INSIDE** the Sun's orbit can be determined by applying the modified form of Kepler's 3rd law to the motion of the Sun about the center of our galaxy.
c. Because of the missing mass problem, it is not possible to constrain the mass of our galaxy.
d. The mass of our galaxy can be be accounted for by luminous material only. There is no need to invoke the presence of dark matter as in external galaxies.
e. The mass of the Milky Way Galaxy **OUTSIDE** the Sun's orbit can be determined by applying the modified form of Kepler's 3rd law to the motion of the Sun about the center of our galaxy.

Answers:

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|---|---|---|---|---|---|---|---|---|---|
| 1(b) | 2(a) | 3(e) | 4(e) | 5(b) | 6(e) | 7(b) | 8(b) | 9(b) | 10(d) |
| 11(d) | 12(d) | 13(a) | 14(c) | 15(a) | 16(a) | 17(b) | 18(a) | 19(d) | 20(c) |
| 21(e) | 22(d) | 23(e) | 24(a) | 25(e) | 26(a) | 27(b) | 28(b) | 29(c) | 30(e) |
| 31(c) | 32(e) | 33(b) | 34(c) | 35(c) | 36(c) | 37(d) | 38(a) | 39(c) | 40(c) |
| 41(a) | 42(a) | 43(d) | 44(b) | 45(b) | | | | | |