Astro 102 Practice Test 3

Multiple Choice
Identify the choice that best completes the statement or answers the question.

1. Interstellar gas clouds may collapse to form stars if they
   a. have very high temperatures.
   b. encounter a shock wave.
   c. rotate rapidly.
   d. are located near main sequence spectral type K and M stars.
   e. all of the above

2. The diagram below is an HR diagram. The line indicates the location of the main sequence. Which of the five labeled locations on the HR diagram indicates a luminosity and temperature similar to that of a T Tauri star?
   a. 1
   b. 2
   c. 3
   d. 4
   e. 5

3. The free-fall contraction of a molecular cloud
   a. can be initiated by shock waves from supernovae.
   b. can be initiated by nearby spectral type G stars.
   c. can be initiated by the rotation of the cloud.
   d. causes the cloud to become transparent to ultraviolet radiation.
   e. causes the particles in the cloud to decrease the speed with which they move.

4. The proton-proton chain needs high temperature because
   a. of the ground state energy of the hydrogen atom.
   b. of the presence of helium atoms.
   c. the protons must overcome the Coulomb barrier.
   d. of the need for low density.
   e. the neutrinos carry more energy away than the reaction produces.
5. The capture of too few solar neutrinos by Davis in the solar neutrino experiment
   a. was disproved by the results of later experiments.
   b. can be explained if the sun is not undergoing thermonuclear fusion of hydrogen in its core.
   c. indicates that the sun's core is much hotter than expected.
   d. indicates the sun's core is convective.
   e. none of the above

6. The carbon-nitrogen-oxygen cycle
   a. operates at a slightly lower temperature than the proton-proton chain.
   b. is most efficient in a star less massive than the sun.
   c. occurs when carbon and oxygen combine to form nitrogen, which produces energy.
   d. produces the energy responsible for bipolar flows.
   e. combines four hydrogen nuclei to form one helium nucleus, which produces energy.

7. Opacity is
   a. the balance between the pressure and force of gravity inside a star.
   b. the force that binds protons and neutrons together to form a nucleus.
   c. the force that binds an electron to the nucleus in an atom.
   d. a measure of the ease with which photons can pass through a gas.
   e. the temperature and density at which a gas will undergo thermonuclear fusion.

8. As a star begins to form the initial energy source is from
   a. nuclear fusion.
   b. nuclear fission.
   c. gravitational potential energy.
   d. magnetic fields.

9. The energy emitted from the surface of a main sequence star is _____ the energy generated in the core.
   a. greater than
   b. less than
   c. equal to

10. There is a mass-luminosity relation because
    a. hydrogen fusion produces helium.
    b. stars expand when they become giants.
    c. stars support their weight by making energy.
    d. the helium flash occurs in degenerate matter.
    e. all stars on the main sequence have about the same radius.

11. As a star like the sun exhausts hydrogen in its core, the outer layers of the star
    a. become hotter and more luminous.
    b. become cooler and more luminous.
    c. become hotter and less luminous.
    d. become cooler and less luminous.
    e. become larger in radius and hotter.

12. Helium fusion is called the triple alpha process because
    a. the helium nucleus is known as an alpha particle.
    b. it occurs very rapidly.
    c. it requires a temperature three times greater than that of hydrogen fusion.
    d. it is the third source of the primary fusion processes.
    e. each reaction produces three carbon nuclei.
13. A star will experience a helium flash if
   a. it is more massive than about 6 solar masses.
   b. its core contains oxygen and helium.
   c. its mass on the main sequence was less than 0.1 solar masses.
   d. it is a supergiant.
   e. its core is degenerate when helium ignites.

14. Which of the following nuclear fuels does a 0.2 solar mass star use over the course of its entire evolution?
   a. hydrogen
   b. hydrogen and helium
   c. hydrogen, helium, and carbon
   d. hydrogen, helium, carbon, and neon
   e. hydrogen, helium, carbon, neon, and oxygen

15. In the diagram below, which point indicates the location on the HR diagram of a one solar mass star when it undergoes helium flash?

   ![Image of HR diagram]

   a. 1
   b. 2
   c. 3
   d. 4
   e. 5

16. Variables of a certain type are called Cepheid variable because
   a. the first one discovered was in the constellation of Cepheus.
   b. they were discovered by Anna Marie Cepheid and her brother Raul.
   c. they all lie in the Cepheus star cluster.
   d. they can be used to determine the distance to Cepheid star clusters.
   e. they can be used to determine the distance to all of the stars in the Cepheid galaxy.

17. It is assumed that stars in a star cluster
   a. all have the same age.
   b. all have the same chemical composition.
   c. all have the same luminosity.
   d. all of the above
   e. a and b above

18. What must occur for an object to be considered a main sequence star?
   a. Hydrostatic equilibrium
   b. Nuclear fusion reaction in the core
   c. Protostar life begins
   d. Both a and b.
19. The carbon-nitrogen-oxygen cycle
   a. operates at a slightly lower temperature than the proton-proton chain.
   b. is most efficient in a star less massive than the sun.
   c. occurs when carbon and oxygen combine to form nitrogen, which produces energy.
   d. produces the energy responsible for bipolar flows.
   e. combines four hydrogen nuclei to form one helium nucleus, which produces energy.

20. A planetary nebula
   a. produces an absorption spectrum.
   b. produces an emission spectrum.
   c. is contracting to form planets.
   d. is contracting to form the star.
   e. is the result of carbon detonation in a 1 $M_\odot$.

21. A typical planetary nebula will be visible for about
   a. 50 years.
   b. 500 years.
   c. 50,000 years.
   d. 5,000,000 years.
   e. 5 billion years.

22. Suppose that a planetary nebula is 0.5 parsecs in diameter and expanding at 20 km/s. How old is it? (Hint: 1 pc = 3.1\times10^{13} \text{ km}.)
   a. 25,000 years
   b. 12,000 years
   c. 6,000 years
   d. 49,000 years
   e. 100,000 years

23. The energy a white dwarf emits into space is
   a. replaced by fusion of hydrogen atoms into helium.
   b. replaced by fusion of helium atoms into carbon.
   c. not replaced.

24. As a white dwarf cools its radius does not change because
   a. pressure due to nuclear reactions in a shell just below the surface keeps it from collapsing.
   b. pressure does not depend on temperature for a white dwarf because the electrons are degenerate.
   c. pressure does not depend on temperature because the white dwarf is too hot.
   d. pressure does not depend on temperature because the star has exhausted all its nuclear fuels.
   e. material accreting onto it from a companion maintains a constant radius.

25. A Type I supernova is believed to occur when
   a. the core of a massive star collapses.
   b. carbon detonation occurs.
   c. a white dwarf exceeds the Chandrasekhar limit.
   d. the cores of massive stars collapse.
   e. neutrinos in a massive star become degenerate and form a shock wave that explodes the star.
26. When material expanding away from a star in a binary system reaches the Roche surface
   a. the material will start to fall back toward the star.
   b. all of the material will accrete onto the companion.
   c. the material is no longer gravitationally bound to the star.
   d. the material will increase in temperature and eventually undergo thermonuclear fusion.
   e. c and d

27. As material leaves an expanding star and begins to fall into a white dwarf
   a. an accretion disk will form around the white dwarf.
   b. the material will cool off because it begins to move at high velocities.
   c. the material will fall directly onto the surface of the white dwarf.
   d. the white dwarf will produce a type-II supernova.
   e. the white dwarf's radius will increase.

28. A type-II supernova
   a. occurs when a white dwarf's mass exceeds the Chandrasekhar limit.
   b. is the result of helium flash.
   c. is characterized by a spectrum that shows hydrogen lines.
   d. occurs when the iron core of a massive star collapses.
   e. c and d

29. What are the two longest stages in the life of a one solar mass star?
   a. Protostar, pre-main sequence.
   b. Protostar, white dwarf.
   c. Protostar, main-sequence.
   d. Main-sequence, white dwarf.

30. Where are elements heavier than iron primarily produced?
   a. Brown dwarfs
   b. White dwarfs
   c. Supergiants
   d. Supernovae

31. The explosion of a supernova typically leaves behind
   a. a planetary nebula.
   b. a shell of hot, expanding gas with a white dwarf at the center.
   c. a shell of hot, expanding gas with a pulsar at the center.
   d. nothing is ever left behind.

32. The density of a neutron star is
   a. about the same as that of a white dwarf.
   b. about the same as that of the sun.
   c. about the same as an atomic nucleus.
   d. about the same as a water molecule.
   e. smaller than expected because the magnetic field is so strong.

33. The density of a _____ is greater than the density of a _____.
   a. white dwarf, neutron star
   b. neutron star, black hole
   c. pulsar, neutron star
   d. pulsar, white dwarf
   e. white dwarf, black hole
34. A pulsar requires that a neutron star
   I. rotate rapidly.
   II. have a radius of at least 10 km.
   III. have a strong magnetic field.
   IV. rotate on an axis that is different from the axis of the magnetic field.
   a. I & III
   b. I & IV
   c. II, III, & IV
   d. I, III, & IV
   e. I, II, III, & IV

35. The event horizon
   a. is believed to be a singularity.
   b. is a crystalline layer.
   c. has a radius equal to the Schwarzschild radius.
   d. marks the inner boundary of a planetary nebula.
   e. is located at the point where synchrotron radiation is created around a pulsar.

36. A rotating black hole
   a. will produce a pulsar.
   b. will have a stronger gravitational field than a non-rotating black hole.
   c. is known as a Schwarzschild black hole.
   d. causes objects near it to produce large amounts of radio energy.
   e. possesses an ergosphere that lies just beyond the Schwarzschild radius.

37. An isolated black hole in space would be difficult to detect because
   a. there would be no light source nearby.
   b. it would not be rotating rapidly.
   c. it would be stationary.
   d. very little matter would be falling into it.
   e. there would be very few stars behind it whose light the black hole could block out.

38. The search for black holes involves
   a. searching for single stars that emit large amounts of x-rays.
   b. finding x-ray binaries where the compact companion has a mass in excess of 3 $M_\odot$.
   c. searching for large spherical regions from which no light is detected.
   d. looking for pulsars with periods less than one millisecond.

39. The escape velocity at the event horizon around a black hole is
   a. smaller than the speed of light.
   b. equal to the speed of light.
   c. larger than the speed of light.
   d. irrelevant since nothing (including light) can escape from a black hole.

40. How far does the Schwarzschild radius of the Sun extend from its center?
   a. A few kilometers away
   b. A few solar radii away
   c. A few astronomical units (AU) away
   d. A few parsecs away
**True/False**

*Indicate whether the statement is true or false.*

___ 41. Ninety percent of all stars fuse helium and lie on the main sequence.

___ 42. Nuclear fusion in stars is controlled by the dependence of density on mass.

___ 43. The sun makes most of its energy by the CNO cycle.

___ 44. Helium fusion does not begin until the star has entered the giant region of the H-R diagram.

___ 45. Even in degenerate matter, pressure depends on temperature.

___ 46. Young star clusters have bluer turn-off points than old clusters.

___ 47. Planetary nebulae are sites of planet formation.

___ 48. Synchrotron radiation occurs when high speed electrons move through a magnetic field.

___ 49. We expect neutron stars to spin rapidly because they conserve angular momentum.

___ 50. The event horizon marks the boundary within which the density is roughly the same as that of the atomic nucleus.
Astro 102 Practice Test 3
Answer Section

MULTIPLE CHOICE

1. ANS: B PTS: 1
2. ANS: D PTS: 1
3. ANS: A PTS: 1
4. ANS: C PTS: 1
5. ANS: E PTS: 1
6. ANS: E PTS: 1
7. ANS: D PTS: 1
8. ANS: C PTS: 1
9. ANS: C PTS: 1
10. ANS: C PTS: 1
11. ANS: B PTS: 1
12. ANS: A PTS: 1
13. ANS: E PTS: 1
14. ANS: A PTS: 1
15. ANS: E PTS: 1
16. ANS: A PTS: 1
17. ANS: E PTS: 1
18. ANS: D PTS: 1
19. ANS: E PTS: 1
20. ANS: B PTS: 1
21. ANS: C PTS: 1
22. ANS: B PTS: 1
23. ANS: C PTS: 1
24. ANS: B PTS: 1
25. ANS: C PTS: 1
26. ANS: C PTS: 1
27. ANS: A PTS: 1
28. ANS: E PTS: 1
29. ANS: D PTS: 1
30. ANS: D PTS: 1
31. ANS: C PTS: 1
32. ANS: C PTS: 1
33. ANS: D PTS: 1
34. ANS: D PTS: 1
35. ANS: C PTS: 1
36. ANS: E PTS: 1
37. ANS: D PTS: 1
38. ANS: B PTS: 1
39. ANS: B PTS: 1
40. ANS: A   PTS: 1

TRUE/FALSE

41. ANS: F   PTS: 1
42. ANS: F   PTS: 1
43. ANS: F   PTS: 1
44. ANS: T   PTS: 1
45. ANS: F   PTS: 1
46. ANS: T   PTS: 1
47. ANS: F   PTS: 1
48. ANS: T   PTS: 1
49. ANS: T   PTS: 1
50. ANS: F   PTS: 1