

Name _____

Do not forget to write your name and fill in the bubbles with your student number, and fill in test form A on the answer sheet. Write your name above as well. You have 50 minutes. For each question, mark the best answer. The formulas you may want are:

$$d = \frac{3.26 \text{ ly}}{p} \quad \frac{L}{L_{\odot}} = \left(\frac{T}{T_{\odot}} \right)^4 \left(\frac{R}{R_{\odot}} \right)^2 \quad L = 4\pi d^2 B$$

- Which of the following spectral type of stars would have a temperature somewhere between a A5 and a G0 star?
A) B3 B) A2 C) G7 D) K4 E) A9
- Which of the following is true about high mass main sequence stars compared to low mass main sequence stars?
A) They are less luminous
B) They have a lower surface temperature
C) They are smaller in radius
D) They are more common
E) None of the above
- In a double shell burning star, why is there no fusion going on at the center?
A) It is too cool to fuse hydrogen
B) There is no hydrogen, and it is too cool to fuse helium
C) There is no hydrogen nor helium, and it is too cool to fuse heavier elements
D) The core has been converted to iron, which does not fuse
E) The density is so low that the nuclei cannot find each other
- Certain objects are “pulsars” the produce extremely regular pulses of light or other radiation. The size of these objects is about the same as
A) A city B) The Earth C) Jupiter D) The Sun E) The Solar System
- Which of the following is likely a sign that a stellar cluster is old?
A) It has become more blue in overall color
B) It has become more red in overall color
C) There are a large number of neutron stars
D) There are a large number of supernova
E) The cluster has very few stars left in it
- How does heat move from the interior to the center to the surface of the Sun?

- A) Convection, or circulation (everywhere)
 - B) Radiation (everywhere)
 - C) Radiation near the center; convection near the surface
 - D) Convection near the center; radiation near the surface
 - E) Apollo transports it using his chariot
7. How large will the Sun be in the core helium burning stage compared to other stages?
- A) Larger than main sequence, but not as large as a red giant
 - B) Larger than a red giant, but not as large as main sequence
 - C) Larger than both main sequence and red giant
 - D) Smaller than both main sequence and red giant
 - E) It depends on exactly where you are on the core helium burning stage
8. Small bright jets that seem to shoot out of the surface of the Sun are called
- A) Spicules
 - B) Prominences
 - C) Flares
 - D) Coronal mass ejections
 - E) Coronal holes
9. During which stage will low-mass stars like the Sun undergo nuclear burning of carbon and oxygen?
- A) Red giant
 - B) Double shell burning
 - C) Planetary nebula
 - D) Supergiant
 - E) Never
10. Suppose we did radar distancing to Venus, and then did it again one month later. Which of the following would indicate that Venus had moved away in the mean time?
- A) The reflected signal takes longer the second time
 - B) The reflected signal takes less time the second time
 - C) The reflected signal is weaker the second time
 - D) The reflected wave is more red-shifted the second time
 - E) The reflected wave is more blue-shifted the second time
11. Nothing can escape from a black hole, and yet I talked about black holes in X-ray binaries. How can this make sense?
- A) *Ordinary* objects can't get out of black holes, but X-rays can
 - B) The presence of a second star disrupts the black hole, allowing X-rays to escape
 - C) The X-rays come from the companion star as the black hole rips through it
 - D) The X-rays are actually ordinary light that has undergone blue shift from the gravitational influence of the black holes
 - E) The X-rays come from a super-hot accretion disk just outside the black hole
12. What happens to a protostar as heat leaks out of it?
- A) It gets smaller and colder

- B) It gets smaller and hotter
 - C) It gets larger and colder
 - D) It gets larger and hotter
 - E) It changes very little, since fusion replaces the heat that is lost
13. When you have charged particles moving in the presence of magnetic field lines, they are forced to
- A) Move along the field lines
 - B) Move across (perpendicular) to the field lines
 - C) Stand still; not move at all
 - D) Move, they can't stand still
 - E) Charged particles are unaffected by magnetic fields
14. Which part of the Sun's atmosphere is the hottest?
- A) Photosphere
 - B) Corona
 - C) Chromosphere
 - D) Troposphere
 - E) Stratosphere
15. Which of the following discoveries was announced this semester in astronomy?
- A) First observation of gravitational waves from the merger of two black holes
 - B) First observation of a supernova for which we had seen the star beforehand
 - C) First observation of a gamma ray burster with an associated visible fireball
 - D) First observation of an X-ray pulsar associated with a black hole
 - E) First observation of fusion beginning in a star
16. What fuel is being burned (fusion), and where, if any, in a red giant star?
- A) Hydrogen at the center
 - B) Hydrogen in a shell (only)
 - C) Helium at the center and hydrogen in a shell
 - D) Both hydrogen in a shell and helium in a shell
 - E) None; red giants are not undergoing fusion
17. Why are there no stars lighter than about 0.08 solar masses?
- A) Such stars have insufficient mass to form
 - B) Gas of such a low quantity would be absorbed by other stars
 - C) These stars never get hot enough for fusion
 - D) These stars take so long to form they are still in the protostar stage
 - E) Such stars probably exist, but are too dim to detect
18. Why does a thin, cool gas with a hot, thick gas behind it produce a dark line spectrum?
- A) Because the thin gas can produce almost, but not quite all, of the spectrum because it is too thin

- B) Because the thick gas produces slightly different wavelengths at each point, and the thin gas only blocks certain locations
- C) Because the atoms of the cool gas absorb very specific wavelengths that is being produced by the thick gas
- D) Because the thin gas has its atoms spaced at just the right separation to act as a diffraction grating, scattering of the light that is hitting it
- E) Because the magnetic fields in the thin gas shift a few frequencies up or down slightly from where they would normally be produced

19. Star A is 81 times brighter than star B, even though they are identical stars. This can be account for if star B is how many times farther away than star A?

- A) 3 B) 9 C) 27 D) 81 E) 6561

20. Most stars, compared to the Sun, during the main sequence, are

- A) More massive and hotter
- B) Less massive and hotter
- C) More massive and cooler
- D) Less massive and cooler
- E) Since they are main sequence, they are actually pretty similar to the Sun

21. What does a planetary nebula have to do with planets?

- A) It is the nebula from which planets form
- B) It is caused by the destruction of planets that originally orbited the star
- C) Its shape is caused by interaction with planets orbiting the star
- D) It contains the same elements that planets are made of
- E) None of the above

22. The second most common element in the star Sirius (a typical star) is

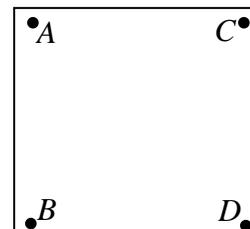
- A) Hydrogen B) Carbon C) Oxygen D) Iron E) Helium

23. What process ultimately leads to the demise of a low mass star like the Sun?

- A) Collapse of the core when it exceeds the Chandrasekhar mass
- B) Loss of mass during some of the giant stages
- C) Complete consumption of all the hydrogen originally in the star
- D) Runaway fusion of heavy elements
- E) Massive mixing that cools the core below the threshold for fusion

24. At right is a qualitative diagram of an HR diagram, with four stars marked. Which star is very luminous, but low in temperature?

- A) A B) B C) C D) D E) Insufficient information



25. Dark spots called “sunspots” are caused by

- A) Places where the hydrogen has run out, stopping fusion
- B) Places where carbon has accumulated on the surface of the Sun
- C) Clouds of opaque gas above the surface of the Sun

- D) Regions of intense magnetic fields that interfere with convection
E) Planets or asteroids passing between us and the Sun
26. What is wrong with the following expression concerning fusion in a star like the Sun?
 $4 \text{ Hydrogen nuclei} + 2 \text{ electrons} \rightarrow 2 \text{ Helium nuclei} + 2 \text{ neutrinos} + \text{energy}$
A) Only three hydrogen should be included
B) You only produce one helium
C) There are no neutrinos produced by this process
D) The energy belongs on the other side, since this requires energy
E) Nothing; the expression is actually right
27. As a white dwarf releases heat very slowly, how does it move on the HR-diagram?
A) Up and to the left
B) Up and to the right
C) Down and to the left
D) Down and to the right
E) None of the above
28. Two stars have equal brightness. Star A is spectral type A5. Star B is spectral type B5.
Which additional information would allow you to conclude something about the two stars?
A) If they are both supergiants, then star A is farther away than star B
B) If they are both supergiants, then star B is farther away than star A
C) If they are both main sequence, then star A is farther away than star B
D) If they are both main sequence, then star B is farther away than star A
E) None of the above
29. About 90 percent of stars are what type?
A) Neutron star B) White dwarf C) Giant D) Main sequence E) Supergiant
30. What clue would indicate that a star is probably moving away from the Sun?
A) The spectrum is stronger at the blue end than typical
B) The spectrum is stronger at the red end than typical
C) The dark absorption lines are shifted towards the blue end of the spectrum
D) The dark absorption lines are shifted towards the red end of the spectrum
E) The star dims gradually over time
31. Which stage of a star comes immediately before the main sequence?
A) White dwarf
B) Red giant
C) Core helium burning
D) Double-shell burning

E) Protostar

32. Which of the following can only occur in systems with more than one star?

A) Nova (only)

B) White dwarf supernova (only)

C) Massive star supernova (only)

D) Nova and white dwarf supernova

E) Nova and massive star supernova

33. In a very massive star, shortly before it dies, what element is abundant at the center?

A) Carbon

B) Oxygen

C) Iron

D) Neon

E) Silicon