

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 55 minutes. For each question, mark the best answer. The formulas you may want are:

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

1. How does a plasma differ from an ordinary gas?
  - A) The atoms are generally in molecules in a plasma, but single atoms in a gas
  - B) A plasma does not satisfy the ideal gas law,  $P = knT$ , unlike a gas
  - C) A plasma maintains its shape, unlike a gas, which can change shape
  - D) A plasma has fixed volume, unlike a gas, which changes volume based on pressure
  - E) A plasma is so hot that the electrons have come loose from their atoms
  
2. How does the number of sunspots differ from time to time on the surface of the Sun?
  - A) It rises and falls roughly with a period of a couple days
  - B) It rises and falls roughly with a period of about 11 days
  - C) It rises and falls roughly with a period of about 11 months
  - D) It rises and falls roughly with a period of about 11 years
  - E) It stays pretty constant over time
  
3. Which would be a clue that a cluster of stars I am examining is probably very old?
  - A) It has a reddish color to it
  - B) It has a blueish color to it
  - C) It is exceptionally bright
  - D) It is exceptionally dim
  - E) It is collecting social security
  
4. How is heat transported from the interior of the Sun to the exterior in the outer layers of the Sun?
  - A) Radiation: by light
  - B) Magnetic induction: by magnetic fields
  - C) Convection: by flowing plasma
  - D) Conduction: by direct physical contact
  - E) Neutrinos: brought out from the interior
  
5. What does a star look like just before a massive star supernova?

- A) It is made almost entirely of hydrogen, with just a bit of helium at the center
  - B) It is made of almost entirely helium, with just a bit of carbon and oxygen at the center
  - C) It is made of almost entirely silicon, with a bit of iron at the center
  - D) It is very complex, with multiple layers made of different things burning to different things
  - E) It is a mixture of many elements, but uniformly mixed throughout
6. In the Doppler method, how do we detect the presence of extrasolar planets?
- A) The light from the planet is alternately red shifted and blue shifted by its motion around the star
  - B) The light from the star is alternately red shifted and blue shifted by the gravitational influence of the planet
  - C) The planet is observed to move slightly to one side and back as it orbits its star
  - D) The star is observed to move slightly to one side and back under the influence of the planet
  - E) Light from a distant star is gravitationally lensed by the planet
7. How does the corona of the Sun compare with the photosphere?
- A) It is much higher temperature and much lower density
  - B) It is much higher temperature and much higher density
  - C) It is much lower temperature and much higher density
  - D) It is much lower temperature and much lower density
  - E) It is comparable in both temperature and density
8. After a massive star supernova, in addition to the supernova remnant, there is also
- A) A neutron star or black hole
  - B) A white dwarf
  - C) A protostar
  - D) A planetary nebula
  - E) Nothing
9. When gas moves from one star to another in a binary system, what is the nature of how the gas is usually transferred?
- A) It comes into the second star uniformly from all sides
  - B) It comes in primarily at the north and south geographic poles
  - C) It comes in straight at the equator, but falling straight into the star
  - D) It forms an accretion disk that orbits the star before falling in
  - E) It forms an ablation sphere that surrounds the star, then slowly flows in
10. What force holds the protons and neutrons together inside a helium nucleus?
- A) Gravity

- B) Electric forces
  - C) Magnetic forces
  - D) The strong force, or strong nuclear force
  - E) The weak force, or weak nuclear force
11. The second most common element in most stars, including the Sun, is
- A) Hydrogen
  - B) Oxygen
  - C) Carbon
  - D) Iron
  - E) Helium
12. Suppose the Sun suddenly doubled its radius, but its surface temperature remained the same. How would its luminosity change?
- A) It would get 16 times more luminous
  - B) It would get 4 times more luminous
  - C) It would get 2 times as luminous
  - D) It would stay the same
  - E) It would get  $\frac{1}{2}$  as luminous
13. The spectrum from the Sun is a
- A) Dark line (absorption) spectrum
  - B) Bright line (emission) spectrum
  - C) Continuous (thermal) spectrum
  - D) White noise (random) spectrum
  - E) None of the above
14. Which of the following is the primary determining factor in how long a star lives?
- A) Composition: Those with high levels of helium die fast
  - B) Composition: Those with low levels of helium die fast
  - C) Planets: Those with the most planets die fast
  - D) Mass: Those with the lowest mass die fast
  - E) Mass: Those with high mass die fast
15. When we look at the “surface” of the Sun, the layer we are actually seeing is the
- A) Radiative zone
  - B) Photosphere
  - C) Corona
  - D) Chromosphere
  - E) Core
16. A star that is very luminous but very cool would appear where on the Hertzsprung-Russell diagram?
- A) Upper right
  - B) Lower right
  - C) Upper left
  - D) Lower left
  - E) Such a star is impossible
17. During which stage of a star like the Sun’s life is it the largest in size?
- A) Protostar
  - B) Double shell burning

- C) Main sequence
- D) White dwarf
- E) Core helium burning

18. Which of the following is true of some extrasolar planet systems?
- A) There are planets much larger than Jupiter (only)
  - B) There are gas giants close to their star (only)
  - C) There are planets in very eccentric orbits, or even going around backwards (only)
  - D) All of the above
  - E) None of the above
19. What sorts of stars will end their life as white dwarfs?
- A) Any star in the main sequence stage
  - B) Any star in the protostar stage
  - C) Low mass stars lighter than 8 times the Sun's mass
  - D) High mass stars heavier than 8 times the Sun's mass
  - E) Stars with a high proportion of helium in their initial composition
20. What is missing from the following net nuclear reaction:
- $$4 \text{ Hydrogen} + 2 \text{ electrons} \rightarrow 1 \text{ Helium} + \text{energy}$$
- A) There should be some neutrinos absorbed by the process
  - B) There should be some neutrinos produced by the process
  - C) There should be carbon interacting as well
  - D) There should be oxygen interacting as well
  - E) Actually, there is nothing missing from this process
21. Suppose that Star A is observed to apparently move from side to side over the course of a year, with a parallax of 0.05 arc-seconds. What is the distance to star A?
- A) 0.0153 ly   B) 0.163 ly   C) 6.13 ly   D) 65.2 ky   E) Insufficient information
22. Which of the following is not true about high mass stars?
- A) They produce many heavy elements by fusion late in their life, like neon, silicon, and iron
  - B) They end their life as a supernova
  - C) During the main sequence they are much brighter than low mass stars
  - D) During the main sequence they have hotter surface temperatures than low mass stars
  - E) After they die, they always end as a neutron star
23. The Sun is currently in which stage of stellar evolution?
- A) Protostar
  - B) White dwarf
  - C) Main sequence

- D) Double-shell burning
  - E) Core helium burning
24. A planetary nebula is
- A) The cloud of gas from which a star forms
  - B) The cloud of gas from which planets form
  - C) The cloud of gas which has been expelled from a star and is illuminated as the star is dying
  - D) A cloud of gas that is left over after a star explodes
  - E) A cloud of gas the is left over after a star evaporates its planets
25. Which of the following observations would be a sign that a star is moving away from us?
- A) The star is gradually getting dimmer over time
  - B) The star is gradually getting more red over time
  - C) The angular size of the star is getting smaller over time
  - D) The spectral lines of the star is shifted towards the blue end of the spectrum
  - E) The spectral lines of the star is shifted towards the red end of the spectrum
26. Between the main sequence and the core helium-burning stage of a star can be found which stage?
- A) Protostar
  - B) Planetary nebula
  - C) White dwarf
  - D) Red giant
  - E) Double shell burning
27. What distinguishes between the protostar stage and the main sequence?
- A) The protostar stage is not yet fusing hydrogen to helium
  - B) The protostar stage is not hot enough to glow
  - C) The protostar stage is already burning helium to carbon and oxygen
  - D) The protostar stage has used up all the hydrogen in its core
  - E) The protostar stage is done with fusion
28. Suppose I have measured the brightness of a star. Which additional piece of information would allow me to determine the luminosity of the star?
- A) Mass   B) Temperature   C) Distance   D) Radius   E) Composition
29. When the Sun has finished its complete life, what elements will have been produced by fusion in its interior?
- A) Helium (only)
  - B) Carbon (only)
  - C) Oxygen (only)

- D) Helium and carbon, but not oxygen  
E) Helium, carbon, and oxygen
30. A typical white dwarf star is about the same size as  
A) A city    B) Jupiter    C) Earth    D) The Sun    E) The Solar System
31. A binary system that produces a supernova has what type of star on which gas is accreting?  
A) A black hole  
B) A main sequence star  
C) A neutron star  
D) A molecular cloud  
E) A white dwarf
32. The Sun is a G2 star. The star  $\alpha$  Centauri A is also a G2 star. What additional piece of information would allow you to conclude that they are probably about the same luminosity?  
A) They are both main sequence stars  
B) They are both about one solar mass  
C) They are at about the same distance from the Earth  
D) They are about the same brightness  
E) None of the above would allow us to conclude that they have similar luminosities
33. Why are main sequence stars the most common type of star?  
A) The star masses that lead to main sequence stars are very common  
B) The main sequence lasts the longest  
C) Stars in our neighborhood are all the same age, and hence all in this stage  
D) The composition of stars leading to the main sequence is the most common  
E) Actually, they are relatively rare, but being the brightest stars, we notice them the most