

Name:

Answer Key

Student ID:

Version 2

Section:

Be sure to read all instructions carefully.

1. [1pt] Which of the following stars would appear brightest in our sky? A star of apparent magnitude equal to

- A) +2
- B) +5
- C) +10
- D) -1
- E) 0

2. [1pt] When the core of a massive star collapses, rebounds, and explodes into a supernova, it picks up much of its energy from the outflow of

- A) ions.
- B) positions.
- C) photons.
- D) neutrinos.
- E) neutral atoms.

3. [1pt] The parallax angle of a star is measured to be 0.33 seconds of arc. The distance to this star is

- A) 10 parsecs
- B) 33 parsecs
- C) 1/3 parsec
- D) 1/9 light year
- E) 3 parsecs

4. [1pt] The object at the center of a black hole is called the _____?

- A) photon sphere
- B) event horizon
- C) centroid
- D) singularity
- E) Kerr metric

5. [1pt] The spectral class adjacent to B0 on the side of warmer color index is _____?

- A) G0
- B) G9
- C) K9
- D) B1
- E) O9

6. [1pt] The Dog Star, Sirius, is a main sequence star that has a higher surface temperature than the Sun. Which of the following would you guess to be the spectral classification for Sirius?

- A) M4
- B) K2
- C) G8
- D) K9
- E) A1

7. [1pt] Pulsars with very short, very stable periods of rotation are called

- A) quick pulsars.
- B) microsecond pulsars.
- C) millisecond pulsars.
- D) fast pulsars.
- E) early pulsars.

8. [1pt] Tremendous explosions in regions around sunspots, which eject particles and emit radiation, are called

- A) coronal holes.
- B) solar flares.
- C) plages.
- D) prominences.
- E) filaments.

9. [1pt] The region around a black hole from which energy can theoretically be extracted is the

- A) photon sphere.
- B) ergosphere.
- C) Schwarzschild radius.
- D) exit cone.
- E) event horizon.

10. [1pt] Which of the following statements is false?

- A) Hot stars are blue and cool stars are red.
- B) To appear equally bright, a star twice as hot must be 4 times farther away.
- C) If we see a blue star and a red star in a nearby star cluster, we know the blue star is hotter.
- D) Blue stars are always more luminous than red stars.
- E) Blue stars are much brighter than red stars of the same size.
- F) At 2 AU the Sun is only one quarter as bright as seen on the Earth.

11. [1pt] As a white dwarf ages it will

- A) cool and shrink.
- B) heat up and expand.
- C) cool and expand.
- D) shrink but remain the same temperature.
- E) cool but remain the same size.

12. [1pt] Why is Jupiter not a black hole?

- A) Planets cannot form black holes because their event horizons would be too small.
- B) Only stars can form black holes.
- C) Jupiter has insufficient mass to form a black hole.
- D) Jupiter's mass is not squeezed into a small enough volume.
- E) Jupiter has a core composed of metallic hydrogen, which is known not to form black holes, though we don't know why.

13. [8pt] Indicate whether the following are properties of Type I or Type II supernovae. Enter I or II for each.

- I Comes from a binary system of a white dwarf and a red-giant.
- I Could completely explode and leave no remnant behind.
- II Leaves behind a neutron star or a black hole.
- I The light-curve does not show a plateau.
- I The spectrum shows very little hydrogen.
- II Produces very heavy elements like Uranium during the explosion.
- II Comes from a massive star that exploded after its core turned to iron.
- I Supernovae of this type have the same peak luminosity.

14. [1pt] The uncharged particle contained within the core of an atom is the

- A) ion.
- B) neutron.
- C) proton.
- D) nucleus.
- E) electron.

15. [1pt] A star that is 100 times fainter than another star at the same distance will be

- A) 2.5 magnitudes dimmer.
- B) 5 magnitudes dimmer.
- C) 3 magnitudes dimmer.
- D) 1 magnitude dimmer.
- E) 10 magnitudes dimmer.

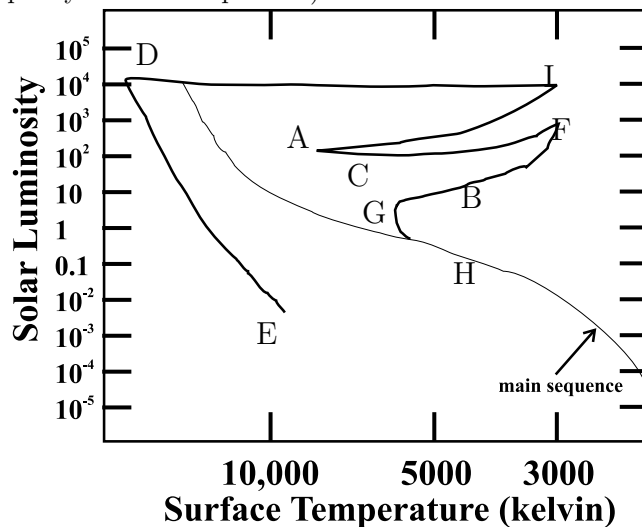
16. [1pt] As the solar atmosphere expands outward into interplanetary space it becomes the

- A) solar wind.
- B) corona.
- C) photosphere.
- D) core.
- E) chromosphere.

17. [1pt] A star that appears brighter to an observer on Earth has a lower

- A) altitude.
- B) declination.
- C) apparent magnitude.
- D) color temperature.
- E) absolute magnitude.

18. [9pt] Identify the location in the H-R diagram of the phases of stellar evolution. (For each statement select the proper symbol in the picture.)



- G hydrogen used up, core collapses
- B hydrogen fusion in shell around core
- H main-sequence star
- A helium used up, core collapses
- I red giant with helium burning shell
- E white dwarf
- D envelope ejected, planetary nebula
- C helium fusion in core
- F red giant, helium flash

19. [1pt] Which of the following objects would you expect to have the highest average density?

- A) a spectral class M2 giant
- B) a spectral class M2 main sequence star
- C) a red supergiant
- D) a spectral class O5 white dwarf
- E) a red giant

20. [1pt] Which statement about the spectral classes of stars is correct?

- A) Cool stars with temperature less than 3500 kelvin show mostly molecular lines because they are made of mostly molecules like TiO.
- B) Type A stars have the strongest visible hydrogen lines because most of the hydrogen is in the ground state.
- C) The spectral types of stars are a result of their different chemical compositions.
- D) Spectral Class K stars are dominated by lines from ionized helium because they are so hot.
- E) Hydrogen lines are weak in type O stars because most of it is completely ionized.

21. [1pt] The angle at which a star appears to move when observed from the ends of a baseline of 1 A.U. is the star's

- A) parallax.
- B) space velocity.
- C) speckle.
- D) proper motion.
- E) radial velocity.

22. [1pt] The number of neutrons in a neutral atom of ${}^6\text{C}^{14}$ is

- A) 2.
- B) 8.
- C) 14.
- D) 20.
- E) 6.

23. [1pt] The distance to a star is measured to be 100 parsecs and the apparent magnitude of this star is $m = +2$. What is this star's Absolute Magnitude, M ?

- A) + 7
- B) - 5
- C) - 3
- D) + 3
- E) - 7

24. [1pt] Which of the following statements is true?

- A) We can infer the internal structure of the Sun by measurement of high energy photons produced in fusion reactions.
- B) The luminosity of a star is measured in Watts per second.
- C) We can learn about the interior of the Sun by watching vibrations on the Sun's surface.
- D) The surface of the Sun has a temperature of about 15,000,000 Kelvin, similar to its core.

25. [1pt] Which of the following types of variable stars appears to always be a part of a binary star system?

- A) nova
- B) type II supernova
- C) long-period red variable
- D) RR-Lyra variable
- E) Cepheid variable

26. [1pt] During most of its lifetime a dwarf star, on the main sequence of a temperature-luminosity diagram, will

- A) stay in about the same place.
- B) move upward.
- C) move to the right.
- D) move to the left.
- E) move downward.

27. [1pt] The 'lighthouse' effect associated with pulsar beams is thought to be associated with _____ ?

- A) the enormous gravitational field of the black hole inside the pulsar
- B) the strong gravitational field of the neutron star
- C) thermonuclear explosions on the surface of the central white dwarf star
- D) the strong magnetic field of the rotating neutron star
- E) the drag exerted on the pulsar by the surrounding nebula

28. [1pt] A stellar sized hot body that derives its energy from free-falling gravitational collapse is a

- A) main-sequence star.
- B) circumstellar disk.
- C) protostar.
- D) white dwarf.
- E) brown dwarf.

29. [1pt] The rule describing the relationship between the temperature of a material and the wavelength of its peak emitted radiation is

- A) Planck's law.
- B) the blackbody rule.
- C) the Wien displacement law.
- D) the Stefan-Boltzmann law.
- E) the quantum theory.

30. [1pt] When a gas removes energy at a particular wavelength from radiation passing through it, it creates a(n)

- A) emission line.
- B) absorption line.
- C) black hole.
- D) continuous spectrum.
- E) stellar spectrum.

31. [1pt] Type II supernovae occur only in

- A) white dwarfs.
- B) double-star systems.
- C) red supergiant stars.
- D) elliptical galaxies.
- E) globular clusters.

32. [1pt] The progenitor of Supernova 1987A was a(n)

- A) brown dwarf in a binary system.
- B) blue supergiant.
- C) main sequence O star.
- D) M star.

33. [1pt] Which statement is true?

- A) Gas falling into a black hole gives off X-rays.
- B) If the Sun collapsed into a black hole the Earth and all the inner planets would be sucked into it.
- C) Light coming from near the event horizon of a black hole would be strongly blue-shifted.
- D) You can tell what material formed a black hole by studying its surface properties.
- E) All stars that have a mass greater than the Sun will end up as a black hole.

34. [1pt] The size of a single star can be determined if we know its absolute magnitude and its

- A) radial velocity.
- B) proper motion.
- C) temperature.
- D) distance.
- E) space velocity.

35. [1pt] The final proof of the nature of pulsars came from observations of the

- A) Crab Nebula.
- B) Small Magellanic Cloud.
- C) Large Magellanic Cloud.
- D) Andromeda galaxy.
- E) Orion Nebula.

36. [1pt] The solar corona is so hot it emits mainly

- A) radio waves.
- B) visible light.
- C) ultraviolet radiation.
- D) infrared radiation.
- E) x-rays.

37. [1pt] Put in order, from earliest to latest, the sequence of events that lead to a star becoming a red giant. Select the correct ordering.

- 1) The core contracts due to gravity and heats up.
 - 2) The envelope beyond the shell becomes convective and the star becomes more luminous.
 - 3) Hydrogen in the core is all turned into helium, and fusion stops in the core.
 - 4) A bigger, cooler and more luminous star has become a red giant.
 - 5) Hydrogen fusion begins in a shell around the core.
 - 6) The shell produces extra energy causing the envelope to expand and cool.
- A) 351624
 - B) 316524
 - C) 315264
 - D) 315624
 - E) 351264

38. [1pt] A nova involves material from a companion star falling on a

- A) white dwarf.
- B) protostar.
- C) dust cloud.
- D) red giant.
- E) main-sequence star.

39. [1pt] If, after a supernova, the stellar core is less than two solar masses, the result will probably be a

- A) black dwarf.
- B) supermassive star.
- C) black hole.
- D) neutron star.
- E) white dwarf.

40. [1pt] The spherical surface around a collapsed star in which light can orbit is the

- A) ergosphere.
- B) exit cone.
- C) photon sphere.
- D) Schwarzschild radius.
- E) event horizon.

41. [1pt] Which of the following stars is at the greatest distance from Earth? A star with parallax angle equal to

- A) 0.5 arcseconds
- B) 0.2 arcseconds
- C) 0.02 arcseconds
- D) 0.1 arcseconds
- E) 0.05 arcseconds

42. [5pt] Match each statement with the appropriate item. Enter the correct letter beside each.

- | | |
|--|----------------------------|
| <u>C</u> young, spread out star cluster | A. horizontal branch stars |
| <u>A</u> globular clusters stars that are burning helium in their core | B. main sequence turnoff |
| <u>B</u> the top of the main sequence of a cluster; more massive stars in the cluster have already evolved | C. open cluster |
| <u>E</u> old, dense star cluster | D. star cluster |
| <u>D</u> group of stars that was formed all at the same time, with the same composition | E. globular cluster |

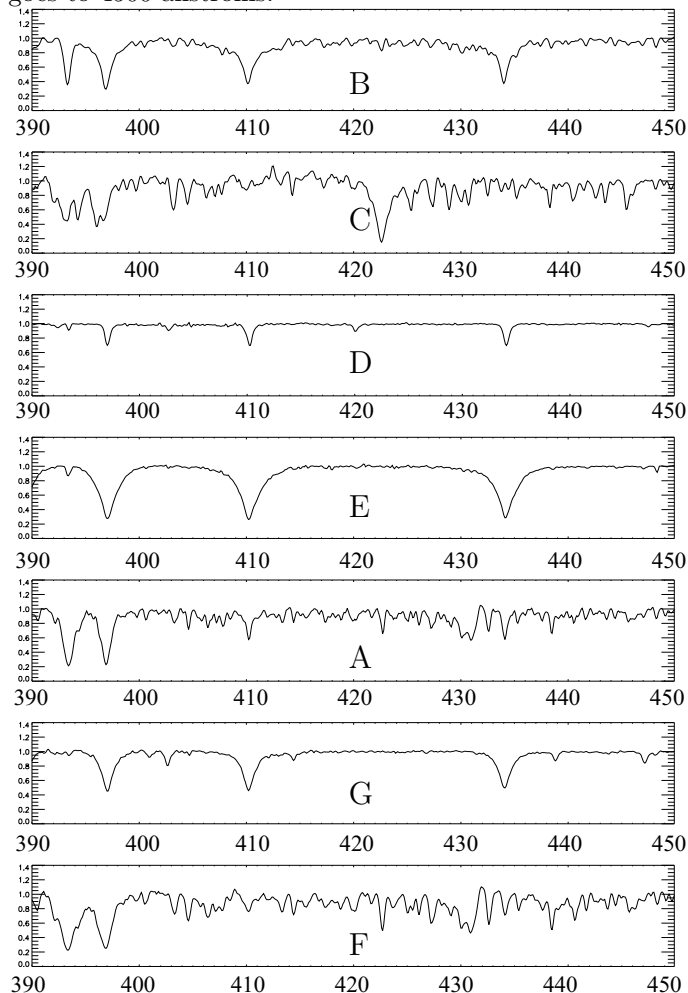
43. [1pt] A 20 solar mass star _____?

- A) contracts very slowly to the main sequence because it is so luminous
- B) will probably become a supernova before reaching the main sequence
- C) burns helium rather than hydrogen while on the main sequence
- D) spends much more time on the main sequence than the sun
- E) spends much less time on the main sequence than a red dwarf star

44. [1pt] If a blue star emits less energy than a yellow star emits, then

- A) the blue star must be smaller than the yellow star
- B) the yellow star must be closer than the blue star
- C) the yellow star must be smaller than the blue star
- D) answer can not be determined without more information
- E) the blue star must be closer than the yellow star

45. [1pt] Digital spectra of each spectral class are shown. Select the correct order of the digital spectra from hottest to coldest. DATA: blue hydrogen lines are at 3970, 4101 and 4471 *angstroms*; calcium II (an ionized heavy metal lines are at 3933 and 3968 *angstroms*. The scale starts at 3900 *angstroms* and goes to 4500 *angstroms*.



- A) ECBAGFD
- B) CBDFAEG
- C) BGCDFEA
- D) DGABEFC
- E) DGEBAFC
- F) GACFGBD

46. [4pt] Match the letter located in the digital spectra above with the correct statement about each spectrum. Enter the letter which labels the matching spectrum on each line.

D Lines of ionized helium; most lines are weak because the star is so hot most electrons are removed from atoms and there are few atoms making transitions.

G Lines of neutral helium. Hydrogen lines moderately strong

C Many lines of neutral elements and molecular states in the coolest of stars.

E Hydrogen lines very strong and dominate the spectrum.

47. [4pt] Identify the spectral type (OBAFGKM) of the given spectra shown above.

B Spectrum G

A Spectrum E

M Spectrum C

O Spectrum D

48. [1pt] An early candidate object possibly containing a black hole was

- A) Sirius.
- B) Cygnus X-1.
- C) Polaris.
- D) Barnard's star.
- E) Subaru.

49. [1pt] Which of the following statements about white dwarfs is false?

- A) Stars with a mass like the Sun will end up as a white dwarf star.
- B) White dwarfs with mass greater than 1.4 times the Sun's mass cannot exist.
- C) The pressure that balances gravity in a white dwarf is called degenerate electron pressure.
- D) White dwarfs cool slowly because they are small and eventually fade-out to become black dwarfs.
- E) The power source of white dwarfs is left-over heat.
- F) White dwarfs are the coolest main sequence stars.

50. [1pt] The Main Sequence generally contains more stars than other regions of the HR diagram because _____?

- A) Only for Main Sequence stars can the color index be reliably determined in order to place them on the HR diagram.
- B) They are the easiest stars to see.
- C) Only for Main Sequence stars can we determine the distance reliably and place them on the HR diagram.
- D) When stars are formed only a few are supergiants or white dwarfs; the vast majority are main sequence stars.
- E) Stars spend a larger percentage of their life on the main sequence than any other region.

51. [1pt] The model that describes pulsars as beams of radio waves from rotating neutron stars is the

- A) neutral pulse model.
- B) lighthouse model.
- C) flashlight model.
- D) searchlight model.
- E) neutron pulsed model.

52. [1pt] The human eye is most sensitive to the _____ portion of the electromagnetic spectrum?

- A) red
- B) violet
- C) orange
- D) blue
- E) yellow

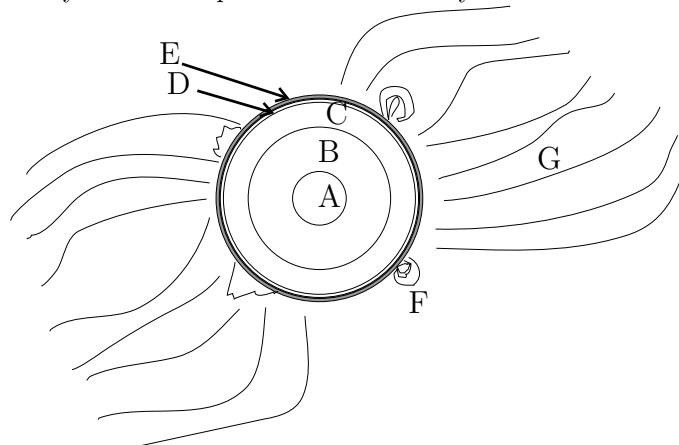
53. [1pt] Which of the following statements is false?

- A) A nova is caused by the buildup of hydrogen on the surface of a white dwarf, which ignites when the temperature and pressure is high enough.
- B) Novae typically occur in a binary system containing a white dwarf.
- C) Stars lose only their outermost layer in a nova explosion.
- D) A nova is when a star explodes at the end of its life.
- E) Novae can occur repeatedly for the same star.

54. [1pt] Compared to surrounding regions on the photosphere, sunspots are

- A) deficient in helium.
- B) hotter.
- C) cooler.
- D) much less dense.

55. [1pt] The figure shows a very simplified version of the structure of the Sun. For each statement below select, in order, the symbol in the picture. Do not use symbols more than once.



A The Hydrogen fusion reactions which power the sun occur here.

G This region has temperatures of 2 Million degrees Kelvin, but is not very dense.

D Most visible light seen from Earth originates in this layer.

F A flare on the solar limb.

E This layer appears reddish due to absorption of Hydrogen alpha light, and contains Spicules

C This layer of the sun has a large temperature difference, which causes hot gas to flow upward.

B This layer of the sun rotates together, as a solid body would.

56. [1pt] After a star enters its red giant phase its core will heat up enough for the triple-alpha process to begin to produce

- A) hydrogen.
- B) helium.
- C) oxygen.
- D) nitrogen.
- E) carbon.

57. [1pt] An electrically neutral gas composed of separate ions and electrons is a(n)

- A) torus.
- B) plasma.
- C) flux tube.
- D) dust cloud.
- E) element.

58. [1pt] The ultimate fate of the Sun is to become a _____?

- A) red supergiant
- B) white dwarf
- C) nova
- D) red dwarf
- E) supernova

59. [1pt] Solar surface granulation is caused by

- A) radioactivity.
- B) radiation.
- C) thermal flux.
- D) conduction.
- E) convection.

60. [1pt] The typical size of a neutron star is of order _____?

- A) 10,000 kilometers
- B) 1000 kilometers
- C) 100,000 kilometers
- D) 10 kilometers
- E) 0.5 kilometers

61. [1pt] The Crab Nebula is the aftermath of a _____?

- A) nova explosion
- B) planetary nebula
- C) supernova explosion
- D) pulsar implosion
- E) collision of two pulsars

62. [1pt] A set of stars that are old and poor in metals (heavy elements) is called _____?

- A) population II
- B) a galactic cluster
- C) luminosity class III
- D) an O-B association
- E) population I

63. [1pt] A very massive star at the end of its main sequence life becomes a

- A) red supergiant.
- B) white giant.
- C) red variable.
- D) white main-sequence.
- E) white dwarf.

64. [1pt] The magnitude a star would have if it were at a standard distance of 10 parsecs is its

- A) relative luminosity.
- B) standard magnitude.
- C) luminosity.
- D) apparent magnitude.
- E) absolute magnitude.

65. [1pt] A neutron star may be surrounded by a disk of material gathered up from a

- A) supernova remnant.
- B) stellar disk.
- C) presolar nebula.
- D) companion star.
- E) planetary nebula.

66. [1pt] Which of the following is true of open clusters?

- A) They typically contain 100-1000 stars.
- B) They contain Population II stars.
- C) They are found in the galactic halo.
- D) They cannot contain luminous main sequence stars.
- E) The central stars in the cluster cannot be resolved from each other.

67. [1pt] A star that is 40 parsecs from the Sun would, if moved to a distance of 10 parsecs, be

- A) 16 times dimmer.
- B) 4 magnitudes brighter.
- C) 16 times brighter.
- D) 4 times brighter.
- E) 4 times dimmer.

68. [1pt] Which of the following is true of typical globular clusters?

- A) they contain stars that are metal-rich
- B) the stars are very young
- C) they contain no supergiants
- D) they are preferentially found in the arms of spiral galaxies
- E) they contain no more than about 10,000 stars

Magnitude/Distance Equations:

$$m_1 - m_2 = 2.5 \log (L_2/L_1)$$

$$m - M = 5 \log (d/10\text{pc})$$

$$d(\text{pc}) = 10^{1+(m-M)/5}$$

Stefan-Boltzmann Equation:

$$L = \text{const.} \times R^2 T^4$$