

Name:	Answer Key
Student ID:	Version 1
Section:	

Be sure to read all instructions carefully.

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

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

2. [1pt] A neutron star may be surrounded by a disk of material gathered up from a

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

3. [1pt] As a white dwarf ages it will

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

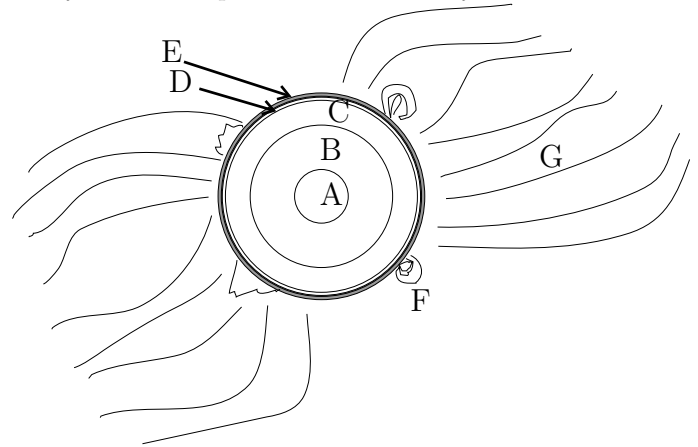
4. [1pt] Which of the following statements is false?

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

5. [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 red giant
- E) a spectral class O5 white dwarf

6. [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.



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

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

F A flare on the solar limb.

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

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

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

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

7. [1pt] Which statement about the spectral classes of stars is correct?

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

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

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

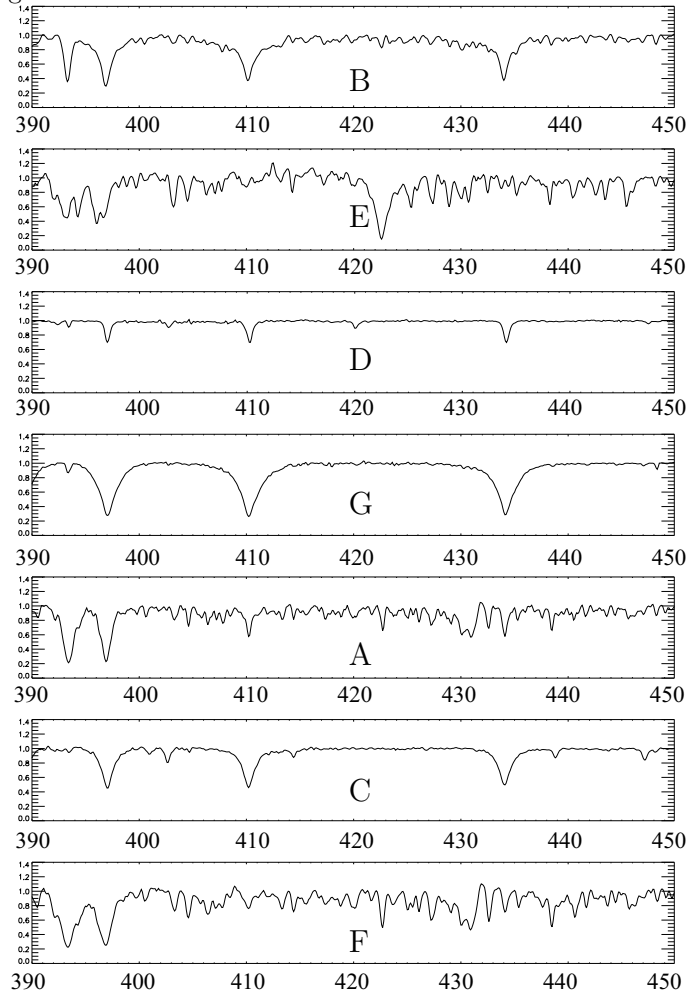
9. [1pt] Which of the following statements is true?

- A) The luminosity of a star is measured in Watts per second.
- B) We can infer the internal structure of the Sun by measurement of high energy photons produced in fusion reactions.
- C) The center of the Sun has a temperature of about 5800 Kelvin, similar to its surface.
- D) We can learn about the interior of the Sun by watching vibrations on the Sun's surface.

10. [1pt] The region around a black hole from which energy can theoretically be extracted is the

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

11. [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) BEGCBFD
- B) DCABGFE
- C) GFDCEAB
- D) AGFEBCD
- E) FBGDCAE
- F) DCGBAFE

12. [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.

- C Lines of neutral helium. Hydrogen lines moderately strong
- 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.
- E Many lines of neutral elements and molecular states in the coolest of stars.
- G Hydrogen lines very strong and dominate the spectrum.

13. [4pt] Identify the spectral type (OBAFGKM) of the given spectra shown above.

- O Spectrum D
- M Spectrum E
- A Spectrum G
- B Spectrum C

14. [1pt] The spectral class adjacent to B0 on the side of warmer color index is _____ ?

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

15. [1pt] Why is Jupiter not a black hole?

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

16. [1pt] Which of the following is true of typical globular clusters?

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

17. [1pt] The number of neutrons in a neutral atom of ${}^6\text{C}^{14}$ is
- A) 20.
 - B) 8.
 - C) 14.
 - D) 6.
 - E) 2.
-

18. [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.
-

19. [5pt] Match each statement with the appropriate item. Enter the correct letter beside each.

D group of stars that was formed all at the same time, with the same composition

- A. main sequence turnoff
- B. horizontal branch stars

C old, dense star cluster

- C. globular cluster

E young, spread out star cluster

- D. star cluster

B globular clusters stars that are burning helium in their core

- E. open cluster

A the top of the main sequence of a cluster; more massive stars in the cluster have already evolved

20. [1pt] The model that describes pulsars as beams of radio waves from rotating neutron stars is the
- A) lighthouse model.
 - B) neutral pulse model.
 - C) neutron pulsed model.
 - D) flashlight model.
 - E) searchlight model.
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21. [1pt] The uncharged particle contained within the core of an atom is the
- A) ion.
 - B) nucleus.
 - C) neutron.
 - D) electron.
 - E) proton.
-

22. [1pt] A nova involves material from a companion star falling on a
- A) white dwarf.
 - B) protostar.
 - C) red giant.
 - D) main-sequence star.
 - E) dust cloud.
-

23. [1pt] A star that appears brighter to an observer on Earth has a lower
- A) apparent magnitude.
 - B) altitude.
 - C) declination.
 - D) absolute magnitude.
 - E) color temperature.
-

24. [1pt] A star that is 100 times fainter than another star at the same distance will be
- A) 10 magnitudes dimmer.
 - B) 2.5 magnitudes dimmer.
 - C) 1 magnitude dimmer.
 - D) 5 magnitudes dimmer.
 - E) 3 magnitudes dimmer.
-

25. [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) radial velocity.
 - D) proper motion.
 - E) speckle.
-

26. [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) +3
 - B) -7
 - C) -5
 - D) -3
 - E) +7
-

27. [1pt] The object at the center of a black hole is called the _____ ?
- A) singularity
 - B) Kerr metric
 - C) centroid
 - D) photon sphere
 - E) event horizon
-

28. [1pt] The size of a single star can be determined if we know its absolute magnitude and its
- A) temperature.
 - B) space velocity.
 - C) proper motion.
 - D) distance.
 - E) radial velocity.

29. [1pt] Which of the following types of variable stars appears to always be a part of a binary star system?

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

30. [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.
-

31. [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.
-

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

- A) 635241
 - B) 653421
 - C) 653241
 - D) 632541
 - E) 635421
-

33. [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) 16 times brighter.
- C) 4 magnitudes brighter.
- D) 4 times dimmer.
- E) 4 times brighter.

34. [1pt] Which statement is true?

- A) All stars that have a mass greater than the Sun will end up as a black hole.
 - B) Gas falling into a black hole gives off X-rays.
 - C) You can tell what material formed a black hole by studying its surface properties.
 - D) Light coming from near the event horizon of a black hole would be strongly blue-shifted.
 - E) If the Sun collapsed into a black hole the Earth and all the inner planets would be sucked into it.
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35. [1pt] When a gas removes energy at a particular wavelength from radiation passing through it, it creates a(n)

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

36. [1pt] As the solar atmosphere expands outward into interplanetary space it becomes the

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

37. [1pt] Type II supernovae occur only in

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

38. [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) photons.
 - C) neutral atoms.
 - D) neutrinos.
 - E) positions.
-

39. [1pt] The progenitor of Supernova 1987A was a(n)

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

40. [1pt] The rule describing the relationship between the temperature of a material and the wavelength of its peak emitted radiation is

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

41. [1pt] The final proof of the nature of pulsars came from observations of the

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

42. [1pt] Pulsars with very short, very stable periods of rotation are called

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

43. [1pt] The solar corona is so hot it emits mainly

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

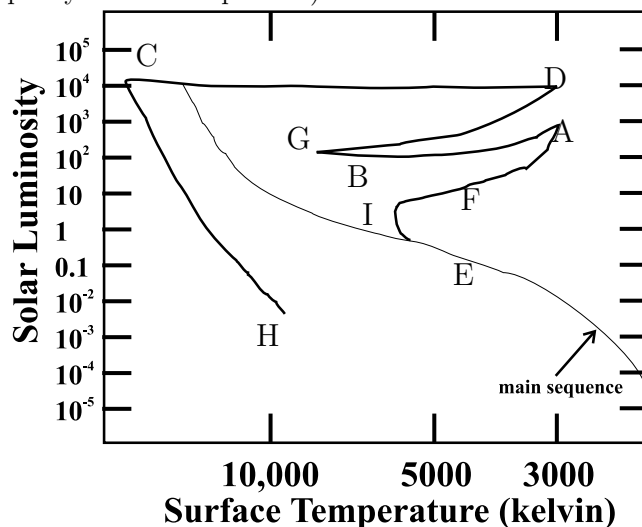
44. [1pt] If, after a supernova, the stellar core is less than two solar masses, the result will probably be a

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

45. [1pt] The spherical surface around a collapsed star in which light can orbit is the

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

46. [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.)



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

47. [1pt] An early candidate object possibly containing a black hole was

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

48. [1pt] The parallax angle of a star is measured to be 0.33 seconds of arc. The distance to this star is

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

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

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

50. [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 blue star must be closer than the yellow star
- D) the yellow star must be smaller than the blue star
- E) answer can not be determined without more information

51. [1pt] Which of the following stars is at the greatest distance from Earth? A star with parallax angle equal to

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

52. [1pt] Which of the following stars would appear brightest in our sky? A star of apparent magnitude equal to

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

53. [1pt] The Main Sequence generally contains more stars than other regions of the HR diagram because _____?

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

54. [1pt] The human eye is most sensitive to the _____ portion of the electromagnetic spectrum?

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

55. [8pt] Indicate whether the following are properties of Type I or Type II supernovae. Enter I or II for each.

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

56. [1pt] Compared to surrounding regions on the photosphere, sunspots are

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

57. [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) G8
- B) M4
- C) K2
- D) K9
- E) A1

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

59. [1pt] An electrically neutral gas composed of separate ions and electrons is a(n)

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

60. [1pt] Solar surface granulation is caused by

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

61. [1pt] The typical size of a neutron star is of order _____?

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

62. [1pt] The Crab Nebula is the aftermath of a _____?

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

63. [1pt] The 'lighthouse' effect associated with pulsar beams is thought to be associated with _____?

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

64. [1pt] Which of the following statements is false?

- A) Novae typically occur in a binary system containing a white dwarf.
- B) 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.
- C) A nova is when a star explodes at the end of its life.
- D) Novae can occur repeatedly for the same star.
- E) Stars lose only their outermost layer in a nova explosion.

65. [1pt] A set of stars that are old and poor in metals (heavy elements) is called _____?

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

66. [1pt] A very massive star at the end of its main sequence life becomes a

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

67. [1pt] A 20 solar mass star _____?

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

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

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

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