Answer Key

Theory

2 pts per question unless stated otherwise

1. a) the Chandrasekhar limit
2. d) Type II have hydrogen lines in their spectra
3. b) they all explode at the same point in their lifetime after passing the limit of 1.4 solar masses so they emit (approximately) the same level of intrinsic brightness allowing astronomers to determine their distances
4. c) 10^{44} Joules
5. c) double degenerate progenitors
6. d) silicon absorption feature at maximum light spectra
7. b) the absorption of higher wavelength light by gas and dust that block distant galaxies from Earth's view
8. d) supernovae (Type Ia)
9. c) mass-transferring binary systems; accretion *(4 pts total, 2 pts for each part)*
10. a) black dwarf

True/False section: 1 pt per question

11. false: Type Ia supernovae are not caused by the collapse of a white dwarf: rather the whole white dwarf detonates due to the presence of all that mass.
12. false: Supernovae explosions have been shown to correspond to increases in neutrino measurements.
13. false: the Sun does not have enough mass to become a neutron star; it will become a white dwarf.
14. true: Type Ia supernovae can outshine galaxies. In fact, they often do when observed.
15. false: A brown dwarf initially has less than 0.08 solar masses.
16. true: SNR is an acronym representing SuperNova Remnant
17. false: If the core of an SNR has a threshold mass of greater than 2-3 solar masses, it will become a black hole.
18. true: Neutron degeneracy is a stellar application of the Pauli Exclusion Principle and will not be able to stop the collapse of a core whose star's mass exceeds 3 solar masses.
19. false: As the mass of stars only on the main sequence increase, the luminosity of the star also increases rapidly.
20. false: only white dwarfs in a binary system that accrete mass from their partner, under a particular set of conditions, become Type Ia supernovae progenitors
21. b) the horizontal branch
22. b) cooler and dimmer
23. a) helium accretes onto the white dwarf and the progenitor is not always destroyed
24. a) the electrons' momentum and therefore the sum of their pressures increases
25. d) open

26. c) thermonuclear runaway supernova
27. d) T Tauri stars
28. d) when it begins fusion of hydrogen into helium
29. a) < 2 solar masses
30. c) supergiant branch star

Short Answer / Circling section: use grader discretion for alternative acceptable answers

31. (2 pts) blue, red
32. (2 pts) separation, stars' period of revolution
33. (2 pts) right ascension, declination
34. (2 pts) albedo
35. (2 pts) ellipses
36. (2 pts) eccentricity
37. (1 pt) infrared
38. (2 pts) 1 [also acceptable: between 1.1 and 0.9], the Earth
39. (2 pts) accretion, pre-main sequence
40. (1 pt) distance
41. (1 pt) 1 (AU)
42. (1 pt) nuclear fusion
43. (1 pt) redshift
44. (1 pt) surface area [also acceptable: radius, diameter, size]
45. (1 pt) solar declination angle
46. (1 pt) parallax second
47. (1 pt) 2.5
48. (1 pt) nuclear fusion
49. (2 pts) blue, red
50. (1 pt) do not
51. (1 pt) Nickel
52. (2 pts) carbon, oxygen
53. (1 pt) convection
54. (2 pts) subsonic, supersonic

Multiple Choice section: 2 pts per question unless stated otherwise

55. Kelvin (temperature)
56. spectral class
57. in spectral class G, slightly above an absolute magnitude of +5 (4 pts total, 2 for each part)
58. d) physical location of stars
59. d) Z

<u>DSOs</u>

4 pts per question unless stated otherwise

60. a) SNR 0509-67.5

b) Large Magellanic Cloud

c) 400 years ago, Southern hemisphere

d) The collision of two white dwarfs (causing a Type Ia supernova explosion)

61. a) SNR 1064 [Kepler's SNR]

b) 1604

c) Kepler

d) shell

62. a) Carina Nebula

b) Nicolas Louis de Lacaille

c) +1.0 [also acceptable: between +1.1 and +0.9]

d) Sir John Herschel

63. a) SN 1885A or S Andromedae

b) August 20, 1885

c) Andromeda

d) It was first observed as uniformly reddish or orange and became red very quickly afterwards - contrary to typical Type Ia supernovae behavior which are usually bluish white before reddening over several weeks reaching peak redness a few days after maximum brightness.

64. a) Proxima Centauri

b) X-ray

c) white dwarf

d) 4.243 ly [acceptable answers between 4.00 and 4.50 ly]

65. a) SNR 1572 [also acceptable: Tycho's SNR, B Cassiopeia, 3C 10]

b) X-ray

c) 8000 - 9000 light years

d) SNR 1572, Tycho's SNR, B Cassiopeia, 3C 10 *(competitors must have two of the answers from the list that are different from their response to (a) to receive the point)*

66. a) Sirius [also acceptable: Sirius A, Sirius (star) system, else grader discretion]

b) A1V

c) 0.98 solar masses

d) 8.2 - 31.5 AU [also acceptable: average 20 AU, grader discretion (0.1 error margin)]

67. a) T Tauri

b) Hind's (Variable) Nebula [also acceptable: NGC 1555]

c) gravitational energy released due to contraction [also acceptable: gravitational contraction]

d) less than 2 solar masses

68. a) SN 2011fe

b) The observation of the supernova was constrained to have a carbon-oxygen white dwarf as a progenitor, proving their role in Type Ia supernovae explosions.

c) +9.9 [also acceptable: grader discretion (0.1 error margin)]

d) Pinwheel galaxy [also acceptable: M101]

69. Sirius [binary star system]

70. Proxima Centauri

Math

All answers have acceptable error margin of 10%.

71. (4 pts) Type Ia SN have relatively standard absolute magnitude of approximately -19.3.

Using the distance modulus, d = $10^{(14.8+19.3)/5}$ =$6.61*10^6$ pc

1 pc = 3.26 ly

d = $2.16*10^7$ ly

[1 pt for equation, 1 pt for answer in pc, 1 pt for answer in ly, 1 pt for sig figs]

- acceptable answers between $2.38*10^7$ and $1.94*10^7$

72. (3 pts) The Inverse Square Law of Brightness states $B = \frac{L}{4\pi d^2}$. $\frac{L_B}{L_A} = \frac{4\pi d_B^2 B_B}{4\pi d_A^2 B_A} = \frac{(18.0\ ly)^2(4.0\mu W/m^2)}{(4.0\ ly)^2(2.0\mu W/m^2)}$

= 40.5x more luminous

[1 pt for showing the inverse square law of brightness, 1 pt for answer, 1 pt for sig figs]

- acceptable answers between 44.6 and 36.5

73. (4 pts) Using $(M_A + M_B)*p^2 = a^3$:

$(m+2m)*p^2 = a^3$

$3m = a^3/p^2$

$m = a^3/(4p^2)$

$= [(80.0\ AU)^3]/[3*(250\ y)^2]$ = 2.73 solar masses

[1 pt for equation, 1 pt for expression of *m*, 1 pt for answer, 1 pt for sig figs]

- acceptable answers between 3.00 and 2.46

74. (4 pts) Newton's Law of Gravitational Attraction: $F = G\frac{m_1 m_2}{r^2}$ rewritten as $r^2 = G\frac{m_1 m_2}{F}$

$= (6.67*10^{-11}\ m^3\ kg^{-1}\ s^{-2})(1.796 \times 10^{30}\ kg)(1.437 \times 10^{29}\ kg) / (5.482*10^{24}\ N)$

$= 3.14*10^{24}\ m^2$

r = sqrt($3.14*10^{24}\ m^2$) = $1.77*10^{12}$ m

1 m = $6.68*10^{-12}$

r = 11.8 AU

[1 pt for equation, 1 pt for answer in m, 1 pt for answer in AU, 1 pt for sig figs]

- acceptable answers between 12.9 AU and 10.6 AU

75. (3 pts) Using Wien's Law, T = $2.9*10^6$ / 483 nm = $6.00*10^3$ K

[1 pt for equation, 1 pt for answer ($6.00*10^3$ K), 1 pt for sig figs]

- acceptable answers between $6.6*10^3$ and $5.4*10^3$

bonus (0 pts): at the V