Reach for the Stars B – KEY

Names:

Team:

Team Number:

Bonus: Gravitational waves from a black hole merger (GW150914)

Section I.a – DSOs

1. Trapezium (Theta^1 Orionis)
2. Will be **pushed away** by radiation pressure
3. Rosette Nebula (Caldwell 49)
4. Shock-heated winds from **hot O/B stars**
5. Nearby superbubble (W4) expanding, or triggered by formation of cluster IC 1795
6. X-rays
7. Carina Nebula (NGC 3372)
8. Eta Carinae (η Car)
9. Bok globule (molecular cloud, dark nebula)
10. Lagoon Nebula
11. W49
12. Radio
13. Pacman Nebula
14. Far above plane of MWG, clearly visible
15. NGC 602
16. Elephant trunks
17. Starburst region
18. Wolf-Rayet stars
19. Omega Nebula (M17)
20. Infrared
21. NGC 2070 (R136)
22. Tarantula Nebula
23. Planetary nebula
24. Cometary knots
25. Cygnus X-1
26. Gas in disk/jets is very hot (millions of K)

27. **Crab Pulsar**

28. Type II(b)

29. 1572

30. Synchrotron radiation (electrons spiraling around magnetic field lines)

31. Radio

32. It was asymmetrical

33. Kepler's SNR

34. "Prompt" Type Ia from massive progenitor (exploded after only a few Myr), or unusually dense ISM)

35. Westerhout

36. Hα

Section I.b – Stars & Constellations

37. Castor

38. Very high rotational speed (86% of breakup)

39. Sirius

40. White dwarf

41. Zeta Ophiuchi (ζ Oph)

42. **Interstellar dust** causes extinction, especially in bluer wavelengths

43. Algol

44. The more evolved star transferred enough mass to the other one to make the second one more massive

45. Betelgeuse is variable by nearly a full mag – only occasionally brighter than Rigel

46. Aldebaran

47. Deneb, Vega, Altair [2 pts]

48. Summer Triangle

49. Orion, Canis Major, Canis Minor [2 pts]

50. **Mizar** (and Alcor)

51. Visual binary (line-of-sight)

52. Sagittarius

53. Cepheid (classical)

54. Vega

Section II.a – Stellar Evolution

55. Mass

56. H II (ionized hydrogen) – accept just H

57. Open clusters

58. Gravity

59. Radiation pressure

60. Hydrostatic equilibrium

61. T Tauri stars

62. Herbig Ae/Be stars

63. Lithium

64.
    a. Pre-MS (protostar)
    b. Red giant
    c. Planetary nebula
    d. White dwarf

65.
    a. Pre-MS (protostar)
    b. Red supergiant
    c. Supernova (Type II)
    d. Neutron star
    e. Black hole

66. Higher fusion rate means more radiation pressure pushing outward

67. Shell

68. Carbon (or oxygen)

69. Iron

70. **White dwarf** accretes enough mass to **exceed Chandrasekhar Limit**, runaway thermonuclear fusion results

71. Progenitor (almost) always has **same mass**

72. None (or companion star)

73. 8 Msun

74. Massive star runs out of energy-producing "fuel", cannot support itself against gravity, results in **collapse**

75. Tolman-Oppenheimer-Volkoff (TOV) Limit

76. Gravitational interactions with other objects

77. Lighthouse analogy

Section II.b – HR Diagram, Spec. Classes

78. Hertzsprung-Russell

79. Absolute magnitude

    Luminosity

80. Color

81. Difference in magnitudes or ratio of fluxes between two different wavelengths

82.
    a. Main sequence
    b. Red giants
    c. Red supergiants
    d. White dwarfs
    e. Blue supergiants

83.
   a. Altair, Sirius, Procyon, Castor, Regulus, Vega, Zeta Oph, Algol, Mizar/Alcor
   b. Capella, Arcturus, Pollux, Aldebaran
   c. Betelgeuse, Antares
   e. Deneb, Rigel

84. O B A F G K M [3 pts]

85. A is strongest

    O is weakest

86. F

87. M

88. B

89. Morgan-Keenan(-Kellman)

90. IV

91. D (or VII)

Section II.c – Calculations

92. 500 pc

93. 1,000,000 pc

94. 10 pc

95. 1/100

96.
   a. 25
   b. 81
   c. 4

97.
   a. 6.25 W/m^2
   b. 0.04 W/m^2

98.
   a. 100 nm
   b. Ultraviolet

99.
   a. 1,000 nm
   b. Infrared

100.
   a. $6 * 10^8$ W/m^2
   b. $6 * 10^{27}$ W