Astronomy C – KEY

Names:

Team:

Team Number:

Bonus: Hulse-Taylor Pulsar (PSR B1913+16, PSR J1915+1606)

Part I - DSOs

1. M42 (Orion Nebula)
2. Trapezium (Theta[1] Orionis)
3. HAT-P-11b
4. Water **vapor**
5. Brown dwarf (GD 165 B)

   Because peak is in infrared
6. T Tauri
7. Burnham's Nebula (HH 255)
8. HD 95086
9. **Hot** inner disk (5-6 AU and 187 K)

   Cold outer disk (64+ AU and 57 K)
10. 55 Cancri (Rho[1] Cancri)
11. **Metals fell in** from protoplanetary **disk**, weak convection mixing because low mass
12. 51 Pegasi b
13. Atmospheric bloating due to **high temps** (because it's so close to its star)
14. Gravity from planet disrupts magnetic field
15. Will break up upon hitting Roche Limit, or spiral into the star
16. WASP-43b
17. Tidal locking
18. Bok globule (dark nebula, molecular cloud)
19. Dust scatters light at visible wavelengths, but IR is long enough to **see through**
20. HL Tauri
21. Very young system, evidence of planets **forming earlier** than they were thought to
22. 2MASS J22282889-431026
23. Differential rotation in atmosphere, "weather" changes with altitude
24. Around 11.6 μm

25. Herbig Ae/Be (HAEBE)

26. Strong asymmetry and gap in disk

27. HR 8799

28. Accept any two of:

Carbon dioxide	(CO_2)
Methane	(CH_4)
Ammonia	(NH_3)
Acetylene	(C_2H_2)

29. Kepler-186

30. First Earth-sized planet in habitable zone

31. Too massive & far out to have formed there

32. Mass difference too large to form as binary with main star

    No nearby massive object to scatter it outward has been found

Part II – Star Formation & Exoplanets

33. HR diagram

34. Difference between app. magnitudes or ratio of fluxes at different wavelengths

35. Straight (diagonal) line

36. Nearby supernova, stellar winds, shockwaves, etc.

37. Shield gas in dark nebula from ionizing UV radiation because it's denser

38. H II (ionized hydrogen) – **accept just H**

39. Lithium

40. Deuterium

41. Forbidden lines

42. Vogt-Russell

43. Hayashi track

    Henyey track

44. Radiation

45. Temperatures appropriate for liquid water

46. Moves outward

    Because the star increases in **luminosity & temperature**

47. Frost line (snow line, ice line)

48. Initial mass function (IMF)

49. FU Orionis stars (FUors)

50. Herbig-Haro object

51. 8 Msun

52. More massive pre-main sequence stars move to MS too quickly for us to observe

53. Gravitational potential energy

54. **Hydrostatic** equilibrium

55. Accretion

56. Poynting-Robertson drag

    Radiation pressure

57. Older stars (10 Myr – 10 Gyr) or main sequence stars

58. Very low metallicity is not enough for planetary formation

59. Chthonian planet

60. Form beyond frost line, then migrate inward where the ices melt

61. Disk interacted with molecular cloud, grav interaction with other matter in disk, star flipped due to magnetic interactions, gravitational capture of planet

62. **Short orbits** – can observe many periods

    Large size – blocks more light from star

63. Gas dwarfs

64. Radial velocity

65. Transit

66. Infrared

    Peak wavelengths for planets are usually IR

67. Rossiter-McLaughlin effect

Part III - Calculations

68.
    a. 0.468 AU

    b. 5500 W/m^2

    c. 380 K, so… not very habitable

69.
    a. 0.48 m/s

    b. Yes, this is just above 0.3 m/s

    c. 0.24 m/s (because sin(i) = ½)

70.
    a. $M_J = 2.04 * 10^{30}\ kg$, so it will collapse

    b. 0.20 hrs

71.
    a. 870 pc

    b. 760 pc

72.
    a. $4.57 * 10^{16}\ kg$

    b. 16.4 Gyr