Team name: ______________________________ Team Number: __________

Astronomy: Answer Key

Katy Regional Tournament 2018
March 24, 2018

Section 1: Deep Sky Objects

1. D
2. C
3. B
4. B
5. D
6. A
7. B
8. A
9. A
10. B
11. A
12. D
13. A
14. D
15. B
16. A
17. C
18. D
19. C
20. B
21. A
22. C
23. A
24. D
25. C
26. B
27. B
28. A
29. D
30. A
31. A
32. A
33. C
34. E
35. A
36. B
37. B
38. A
39. E
40. C
41. A
42. C
43. B
44. A
45. A

Section 2: Calculations and Applications

46. (a) 5.984×10^8 km
    (b) 1.988×10^{31} kg
    (c) 0.015"
    (d) 4.95×10^{-4} rad
    (e) 4.618×10^{31} Watts
    (f) 11.7 light years
    (g) 10^{19} erg
    (h) 0.7 micrometers
    (i) 18.46 kpc
    (j) 6.955×10^{11} m
    (k) 6565.6 square degrees
    (l) 9.454×10^{17} cm/yr
    (m) 2×10^{-18} s^{-1}

47. 105 to 106 years

48. (a) 4.731×10^{10} km
    (b) 6700 to 7000 light years
    (c) 1.0×10^{14} to 1.2×10^{14} km

49. (a) 30-31 km
    (b) 1.44×10^{17} Newtons
    (c) 1.448×10^{-14} m/s^2
    (d) Spaghettification depends on the gradient of the gravitational force; essentially, it's because of the difference in the force on the top of your body and the bottom. For smaller black holes, the gravitational field is much steeper (think about the graph of $1/r^2$ near $r = 1$ and for very large values of r), resulting in much more extreme spaghettification.

50. (a) 2.16×10^{35} Joules
    (b) 150,000 to 160,00 solar luminosities
    (c) 30 to 31 solar masses
    (d) M
    (e) 1000 to 1100 solar radii
    (f) A or Z
    (g) The approximation only works for main-sequence stars and from the properties of this star, we can see that it is likely a red supergiant.
    Numerical estimations show that the mass-luminosity relation is proportional to $M^{3.5}$ for stars of about 2 to 20 solar masses. If this star were to be a main sequence star, the relation would be proportional to only M based on its mass.

51. (a) 10^{46} to 10^{47} Joules
    (b) 10^{44} Joules

52. (a) 81.5 light years
    (b) Bigger
    (c) Observations on Mars, which is a superior planet (meaning that it is further from the Sun than Earth), mean the astronomers will have a bigger baseline since Mars's orbit is bigger.
    (d) Current telescopes/technology have difficulty detecting more precise parallax angles
    (e) Space-based telescopes are not hindered by the Earth's atmosphere

53. (a) 6400 to 6500 Kelvin
    (b) Taking the derivative (and then setting it equal to 0 to find the maximum)
    (c) 500 nm
    (d) The star gets bigger. Its radius increases by a factor of about 1.2

54. (a) 14.6 Gyr
    (b) 1.38×10^{10} light years
    (c) 5×10^{78} to 5×10^{79} cubic meters
    (d) 160 to 161 Mpc
    (e) -21 to -21.5
    (f) 35.7 to 36.2

55. (a) Logarithmic
    (b) Gauss
    (c) 1 second
    (d) Right
    (e) E
    (f) At this location, the pulsars either emit much less radiation or turn off altogether, making them harder (if not impossible) to detect
    (g) Death line
    (h) Spin-up line
    (i) Millisecond pulsar (MSP)
    (j) Magnetar
    (k) Field decay
    (l) Shorter

(m) Faster

(n) H

(o) Magnetic dipole radiation is proportional to B^2/P^4. As a result, we're looking for the location that has the shortest period and strongest magnetic field, which is H.

56. **Tiebreaker:** $\frac{\pi^2}{6}L$

3blue1brown's video on this can be found at `youtu.be/d-o3eB9sfls`