Science Olympiad UT Invitational

October 29, 2022

Astronomy C Answer Key

ANSWER KEY ANSWER KEY
ANSWER KEY ANSWER KEY
ANSWER KEY ANSWER KEY
ANSWER KEY ANSWER KEY
ANSWER KEY ANSWER KEY
ANSWER KEY ANSWER KEY
ANSWER KEY ANSWER KEY
ANSWER KEY ANSWER KEY
ANSWER KEY ANSWER KEY
ANSWER KEY ANSWER KEY

Section A (75 points)

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

Section B (55 points)

1. (a) R Hydrae
   (b) (380-410)
   (c) Mira
2. (a) Image B3
   (b) Gamma-ray pulsar. (One point for antimatter beam or pulsar.)
   (c) Positron, electron
3. (a) AG Carinae
   (b) Gas and dust from the star
   (c) 5
   (d) Artifacts [1 pt] called diffraction spikes formed by light diffracting around support vanes in reflecting telescopes [3 pts].
4. (a) Red giant, white dwarf, and nebula
   (b) Optical, X-ray
   (c) Thermonuclear fusion of hydrogen [2 pts] on the white dwarf once a critical mass of accreted matter from the donor red giant is reached [2 pts].
   (d) 1000
5. (a) NGC 7027
   (b) 920
   (c) Pinched dusty waist, polar lobes/outflows
6. (a) Blackbody
   (b) Oxygen
   (c) Yes [1 pt], there is minimal absorption in the visible region [2 pts].
7. (a) GW 170817
   (b) Spectrogram [1 pt]. It displays signal strength at specific frequencies (signal in frequency domain) as a function of time. Must mention all three: signal strength/intensity, frequency, and time [2 pts].
   (c) Lower binary neutron star (BNS) horizon (lower sensitivity) and poor orientation of detector relative to the source (either accepted).

Section C (20 points)

1. 11:21:(14-16), -60:37:(15-33)
2. 2.0-2.5 times brighter
3. -0.75 to -1.00
4. Start: 68635000-68638500 [1 pt]

   End: 68644000-68646400 [1 pt]
5. In the period of brightening, there is a massive hump not seen in the dim image. Must mention the hump is an added feature for full credit.
6. During the brightening period, the object changed intrinsically. (Full points for any mention or form of intrinsic change.) (Two points for suggesting outburst or ejecta.)
7. No, this did not appear to permanently affect this object [1 pt]. The spectrum from before the brightening period is the same as the spectrum from after the brightening period [3 pt]. (Other answers with sufficient reasoning are also accepted.)

Section D (60 points)

1. (a) Cepheid variable [1 pt]. The most significant feature is the rapid rise and slow drop of its magnitude [2 pts]. (One point for mentioning period length only.)
   (b) This means that range of time between the first and last observation is greater than the period and observations greater than one period past the first observation are "folded" into the chosen period length [1 pt]. If the chosen period length does not coincide with the actual period, then the final light curve looks like a random scatter plot, rather than a nice periodic graph [1 pt].
   (c) 10.9 (9.99-12.7)
   (d) 1.82 (1.73, 1.91)
   (e) (5400-5800) and (6600-6900)
   (f) 23.9%-31.3%
   (g) 16600
   (h) Parallax is only accurate up to at most 1000 pc, which is much smaller than the calculated distance [1 pt]. A Type Ia supernova would be fairly accurate due to it bring a bright standard candle [1 pt]. Hubble's law is only accurate at extremely large distances (on the order of Mpc) and the variation of stellar velocities would be much greater than the effects of Hubble's law [1 pt].

2. (a) There are two concentric circles [0.5 pts] representing the orbit of the stars, with one circle 4-5 times larger [0.5 pts]. The star on the larger orbit is on the top left [1 pt] and the star on the smaller orbit is on the bottom right [1 pt].
   (b) The systemic radial velocity vector points downwards from the center of the two circles [1 pt] with a magnitude of 45 [1 pt]. The other velocity vector starts from the star on the larger circle and point to the top right, tangential to the circle [1 pt]. It has a magnitude of around 190 [1 pt]. (Technically due to the contribution of the systemic radial velocity, it should be a bit less than 190.)
   (c) 3.36×10^{30}
   (d) 0.225
   (e) The velocity curve would still be a simple sinusoid [1 pt]. Only the radial velocity will be scaled by a factor of $\sin(30°)$. An additional velocity in the in/out-page direction will also follow the radial velocity sinusoid scaled by $\cos(30°)$ [2 pts].

3. (a) Apply a logarithm to the period [2 pts] and plot it against the apparent magnitude [1 pt]. Mark and label axes [2 pts]. No units necessary.
   (b) Period increases with magnitude.
   (c) Draw lines of best fit between stars A, D, and E (m_1) [1 pt], and stars B, C, G, and H (m_2) [1 pt]. Using linear regression, we get $m_1(P) = -1.84 \log P + 16.8$ [2 pts] and $m_2(P) = -1.89 \log P + 18.2$ [2 pts].
   (d) Star F [1 pt]. It could be a pulsating variable operating with a different mechanism [2 pts].
   (e) 1.91
   (f) There may be some standardized extinction effect on the dimmer stars, as extinction in the range of a few magnitudes is possible. This would be possible if the host galaxy was a spiral being viewed face-on and the variable stars were located on either side of the galactic disk. (Other answers with sufficient reasoning are also accepted.)