Science Olympiad
Northview Invitational
December 6, 2025

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

Section A [60 points]

1. D	2. B	3. D	4. D
5. A, D	6. B	7. C	8. A
9. A, C	10. B, D	11. C	12. B
13. C	14. B	15. D	16. A
17. C	18. C	19. A	20. C
21. A, D	22. E, G	23. C	24. A
25. D	26. A, B		

Section B [100 points]

27. [2 pts] (Slower) gas motion from thermal pressure counteracts gravity OR mentions higher density

28. [2 pts] Collapsing gas clouds fragment into multiple pieces

29. [2 pts] Pulsars emit radiation in narrow beams (1), and we can only detect beams that sweep across Earth (1)

30. [2 pts] White dwarfs typically explode at roughly the same mass (Chandrasekhar limit) which yields a consistent intrinsic brightness

---

31. [1 pt] Color-magnitude plot (Half credit for H–R diagram OR color-color plot OR mentions color)

32. [3 pts] Main sequence line (1 each), turnoff point (0.5 each)

33. [3 pts] Houcusphi is older (1) because its turnoff point is located further down the main sequence line (OR see presence of post main sequence stars—e.g., red giants) (2).

34. [3 pts] Correct location and properly labeled (1 each)

35. [1 pt] RR Lyrae

36. [1 pt] (Lomb–Scargle) periodogram OR fast fourier transform (FFT) OR peak-to-peak OR phase dispersion minimization. Other answers may be accepted.

37. [3 pts] Phase-fold (1) by replacing the time-axis values t with the remainder of t/P (i.e., t modulo P) (2). This process "stacks" cycles on top of each other and reveals the underlying periodic behavior.

---

38. [5 pts] (a) [2 pts] Nadir and Barnes are cooler.
    (b) [2 pts] Nadir has a lower mass. Barnes has a higher mass.
    (c) [1 pt] Nadir is less luminous. Barnes is more luminous.

39. [3 pts] Barnes (1) is more likely to produce a P Cygni profile (1) since supergiants are more likely to have strong enough stellar winds to produce it (1).

---

40. [1 pt] IC 348

41. [3 pts] Average: 6 [2, 20]
    Range: 13 [8, 20]

42. [3 pts] There is a huge spike in the light curve (2), followed by another smaller spike (1).

43. [3 pts] Flares of the protostar

44. [2 pts] B

45. [3 pts] 0.05 ly (Also accept: 5×10^{-4} ly, 5 ly, and 50 ly) (Accept mantissa in range [4.5, 5.5])

46. [2 pts] Globular cluster (Do NOT accept open cluster)

47. [2 pts] These likely will have exploded as supernovae (Half credit for post main sequence OR "died")

---

48. [2 pts] Infrared

49. [4 pts] Expanding radially out from the central star (1.5), sparse, hot, ionized gas collides with denser, cooler, neutral gas (1.5) ejected earlier in the star's lifespan. This forms an ionized front that is swept back to form the tail (1).

50. [2 pts] $0.13\,M_\oplus$ [0.05, 0.2]

---

51. [2 pts] Zwicky Transient Facility (Do NOT accept ZTF)

52. [3 pts] As Janus is a periodic variable WD, "phase" refers to the time fraction of the light curve (1.5) each spectrum corresponds to—collected over many periods, then stacked—thereby "resolving" them (1.5).

53. [3 pts] Absorption. Its atmosphere OR surface.

54. [2 pts] 0.5

---

55. [1 pt] Positive

56. [4 pts] Lower mass stars are unable to raise their cores to high enough temperature for the triple-alpha process (helium burning) (2). Higher mass stars begin burning helium before its helium core becomes fully degenerate (2) (Half credit for mentioning a "smooth transition").

57. [3 pts] It is absorbed by the expansion of the non-degenerate, outer layers (1.5) against gravity (1.5).

---

58. [3 pts] Parallax equation ($d = 1/p$) 6.67 pc (Exact)

59. [3 pts] Distance modulus ($m - M = -5 + 5\log d$) 10.1 (Exact)

60. [3 pts] Wien's law ($T_{\text{eff}} = b/\lambda_{\max}$) 6000 K [5750, 6250]

61. [3 pts] Stefan–Boltzmann law ($L \propto R^2T^4$) 1.44×10^9 m [1.32, 1.57]

---

62. [3 pts] Kepler's 3rd law ($G(M+m)/(4\pi^2) = a^3/T^2$) 1.82×10^{10} m [1.63, 2.00]

63. [2 pts] Law of gravity (GMm/a^2) 1.12×10^{30} N [0.92, 1.39]

64. [4 pts] Circular motion ($2\pi a = Tv$) 132 km/s [118, 145]
Plug in to get -1.01×10^{40} J [−0.62, −1.45]

65. [3 pts] Negative (1); the system is gravitationally bound in a stable orbit (2).
