

UMSO Astronomy Key

Grading Instructions:

- For each part of a question (i.e. Part a, b, c), give 1 point per part of question. Exceptions are listed below.
- Questions listing multiple image numbers include 1
 - Give 2 points for a correct answer
- Questions involving explanations (with longer, multi-point answers) include 23f:
 - The answer receives points in parts demarcated by brackets (e.g. Explanation 1 [1 point] Explanation 2 [1 point]).
- Difficult math-related questions are given 2 pts, including:
 - 21b, 21d, 22c, 23b, 23c, 23d, 23e, 24a, 24b, 24e
- Tiebreakers are bolded and underlined on the key (e.g. “**TB 1”). If teams tie, check if one team got a question right and the other did not from the following list (in order)
 - 24f, 16c, 12b, 23f, 7c, 24b, 3c, 22b, 8c, 21d, and 11a**

Note: I meant there to be more partial credit for this test. Unfortunately, due to lack of graders, I did not have the time. For example, at a regional I would normally give partial credit or change questions like 1 as distance measurement is difficult and varies with references.

UMSO Astronomy Answer Sheet

Team Name/Number: Astronomy

Grade: 100%

Raw Score: 85/85

Section A

1. 11, 13, 5, 16
2. HR 5171 A
3. (a) NGC 6357
(b) Ionized
(c) X-rays [**TB 7**]
4. (a) Image 11
(b) Image 4
(c) OB Association
5. (a) Betelgeuse or Alpha Orionis
(b) Angular size or angular diameter
(c) Limb darkening
6. (a) Image 12
(b) Spikes (accept variants, like “random spikes”
or “large fluctuations in magnitude”)
(c) Core-collapse, Type II, or Type IIb
7. (a) B
(b) Absorption
(c) N [**TB 5**]
(d) S Doradus instability strip
8. (a) HR 5171 A
(b) Image 18
(c) 90 degrees [**TB 9**]
9. (a) Image 3
(b) Radio
(c) Jets
10. (a) ASASSn-15lh
(b) Magnetar (do NOT accept pulsar)
(c) Tidal Disruption Event
11. (a) H or Hydrogen [**TB 11**]
(b) Spectrum b
(c) Core-collapse (of a massive star)
12. (a) Neutron star or pulsar
(b) Nowhere or none [**TB 3**]
(c) Image 19
13. (a) Image 14
(b) Shock wave
(c) Mixed morphology
14. (a) W49B
(b) It is asymmetric (accept variations)
(c) Type Ib or Ic SN (can also add bipolar, but
need Type Ib or Ic)

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15. (a) Image 8

(b) Gamma-ray

(c) Lighthouse effect

16. (a) Image 7

(b) Radiation pressure and gravitational force

(c) Lower, Eddington limit is proportional to mass (pulsars have lower mass than that of black holes) [**TB 2**]

17. (a) PSR B0355+54 (also accept B0355)

(b) Pulsar Wind Nebula or PWN

(c) Bow shock

18. (a) Image 1

(b) Large Magellanic Cloud or LMC

(c) M or N

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Section B

19. 2 kpc

20. 5300 K

21. (a) 22.21 km

(b) 3.26×10^{17} kg/m³

(c) 6.99×10^9 N

(d) 63,200 K [**TB 10**]

22. (a) Henrietta Swan Leavitt

(b) -4.48 [**TB 8**]

(c) 7.86 kpc

(d) Accept Large Magellanic Cloud (LMC) or Small Magellanic Cloud (SMC)

23. (a) 1.43 au

(b) 181 Msun

(c) 252 Rsun

(d) 1.08

(e) 2.88×10^6 Lsun

(f) $L_{\text{Edd}} = 5.80 \times 10^6$ Lsun [1 point]

This star would have outflows because its luminosity exceeds the Eddington limit [1 point] [**TB 4**]

24. (a) 42.8 ly

(b) 17.48 Msun [**TB 6**]

(c) Type II or Type II-P

(d) 111.5 km/s

(e) 0.0452 nm

(f) Any of: Increase λ_0 ("rest wavelength", this has to be sufficiently explained, though), look for larger SNRs,

look for more distant SNRs [**TB 1**]