

December 8th, 2018
TROY INVITATIONAL



KEY: Astronomy C

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Questions?
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Directions:
Unless otherwise stated, each subquestion is worth two points.

1 Answer Key: Part A

1. (a) Milky Way Galaxy (+2)
 (b) Instrumental Noise (+2)
 (c) -20– -21 (+2)
 (d) 27 – 28 Mly (+2)
 (e) Higher (+1)
 NGC 891 is viewed edge-on (+1)
 (f) Mentions dust (+1)
 Dust scatters light OR re-emits light in the IR (+1)
2. (a) M82 (+1), Ultraviolet (+1)
 (b) Winds of massive stars (+1)
 Ejecta of core collapse supernova (+1)
 (c) $15 - 20 M_{\odot} \text{yr}^{-1} \text{ kpc}^{-2}$ (+2)
 (d) 2 orders of magnitude (+2)
3. (a) B (+2)
 (b) No change/ does not affect (+2)
 (c) Low to zero metallicities (+1)
 In these conditions, stars of higher masses form, so the slope is shallower/ less negative /decreases in magnitude (+1)
 (d) Inverse (+2)
4. (a) IC 10 (+1), IC 10 X-1 (+1)
 (b) Any mention of X-ray binary (+1)
 If specifically HMXB or "Wolf Rayet" X-ray Binary, then (+2)
 (c) Perinigricon (+2)
 (d) $A = \frac{2r_a r_p}{r_a + r_p}$ (+6)

2 Answer Key: Part B

5. (a) O, Ne, Mg, Si, S, and Ca (+1)
The triple-alpha process (+1)
- (b) Cr, Mn, Ni, Fe, and Co (+1)
Supernova nucleosynthesis (+1)
- (c) Later (+1)
The timescale of evolution of Type Ia supernova is much longer (+1)
- (d) Higher (+1)
Initially, there are relatively more Type II compared to Type Ia because higher mass stars evolve more quickly (+1)
- (e) A (+1)
It built up more oxygen before the iron peak elements kicked in (+1)
- (f) Bulge: A (+1)
Dwarf Galaxy: C (+1)
6. (a) Thompson scattering of free electrons (+2)
- (b) Constant (+2)
- (c) $1.5 - 1.6 \times 10^4 L_{\odot}$ (+2)
- (d) $4 - 5 \times 10^2 R_{\odot}$ (+2)
7. (a) GW170817 (+1), Hydra (+1)
- (b) Short gamma-ray burst (+2)
- (c) Black hole (+2)
- (d) Decreases(+1), Gravitational Redshift (+1 points)
- (e) Slower (+1), Time Dilation (+1 points)
8. (a) No (+1), solar motion (+1)
- (b) $10.1 - 10.9 \text{ kms}^{-1}$ (+2)
- (c) $5.4 - 5.9 \text{ kms}^{-1}$ (+2)
- (d) $0.2 - 0.40''$ (+2)
- (e) $3.1 - 3.3 \text{ pc}$ (+2)
- (f) $-2.8 - -3.4$ (+2)
- (g) Sagittarius A* (+2)

Grader's Note: Problem 8 is harder than expected. Precise answers should account for oscillatory motion, similar to how Barnard's star is treated in [here](#). Because of the challenge, the above answer ranges have extended to allow for a simpler method that assumes linearity in the star's motion.