Astronomy Tryout Exam Key

Section A

1. Alfa Orionis
   (a) Betelgeuse
   (b) Semiregular variability

2. Image 5, SN W49B
   (a) Radio
   (b) Distribution of sulfur and silicon, morphology (expanded more from poles than at equator)

3. Geminga appears edge-on, while B0355 is face-on.
   (a) Torus
   (b) Geminga has strong gamma rays (1), while B0355 has stronger radio signals (1). This is because Geminga's torus, the object emitting the gamma rays is face-on while B0355's jets, the objects emitting the radio signals are face-on/torus is edge-on (2).

4. (a) Blue supergiant
   (b) Cobalt (specifically Co-56); x-ray and gamma ray observations.
   (c) Interaction between stellar wind released by the star prior to the explosion and gas from the explosion itself.

5. Image 4, Sharpless 11
   (a) X-ray
   (b) HII region

6. DEM L241
   (a) Oxygen, neon, and magnesium

7. Blue, purple
   (a) Eddington Limit
   (b) Infalling matter falls along magnetic field lines

8. They are the same set of stars, however S Doradus represents the star during quiescence, and LBV during outburst.
   (a) AG Carinae, star illuminates previously ejected material

9. Image 11
   (a) Red supergiant
   (b) Wind Roche Lobe Overflow (WRLOF)

10. Light echos
    (a) Distance
    (b) Any two of: strong x-ray flares, surpases the eddington limit (has more radiation pressure outward than gravitational pressure inward), jet of high-energy particles at near-light speeds

11. J0617, Neutron star/pulsar

(a) Location where particle wind from the pulsar is slowing down OR shock wave travelling ahead of pulsar wind

12. Two of: superluminous type 1 supernova OR magnetar OR quark nova inside a Wolf-Rayet star OR black hole tidal disruption OR simultaneous gravitational lensing event

    (a) A total lack of spectral features

13. Image 9

    (a) It is the slowest spinning neutron star/magnetar, which is odd since the spinning creates the strong magnetic fields in the first place.

14. NGC 7822

    (a) 2 star formation regions, 4 massive stars, 5 Type II supernovas, 3 pulsars, and 2 binary systems

Section B

1. (a) C
   (b) B
   (c) 399.98 nm
   (d) 300-330 parsecs. The period is roughly 3.5 days, plugging this into the period-luminosity relation we get an absolute magnitude of -3.48, and plugging this into the distance modulus with an apparent visual magnitude of 4.0, we end up with 313 parsecs.
2. (a) $M_A = 7.23 - 7.99 M_{solar}$ and $M_B = 2.98 - 3.30 M_{solar}$
   (b) $a_A = 0.18 - 0.20$ AU and $a_B = 0.45 - 0.49$ AU
   (c) Spectral class B
   (d) Black hole
   (e) -15 km/s, moving towards us
   (f) 1.92-2.88E14 years
3. (a) 0.005 s
   (b) 8.7-9.7E10 G
   (c) 1.02-1.38E49 W (negative sign also acceptable)
4. (a) Answers may vary: The iron peak in the nuclear binding energy determines that all nuclear reactions with iron are endothermic. As exothermic fusion reactions allow for local thermodynamic equilibrium in stars, massive stars near death fusing iron cannot maintain themselves as the iron fusion cannot counteract the inward pressure from gravity.
   (b) $z = 0.026 - 0.031$
   (c) $D = 121 - 148$ Mpcs
   (d) Answers may vary: Type II-n supernovae are characterized by a dense circumstellar medium, indicating **high rates of mass loss** of the star before supernova detonation. Type II-b supernovae have two main possible progenitor scenarios- a massive star having lost most of its hydrogen through envelope ejection or interaction with a binary companion stripping the outer layer of hydrogen.
5. (a) 40-50 Square arcminutes
   (b) 9,000-13,000 km/s
   (c) 10^{50} - 10^{52} Ergs