

Answer Page: Section A (1 point each)

1. (a) 3, 15
(b) Spiral and/or starburst
(c) SN 2014J
(d) Type Ia
(e) No X-rays were seen
(f) M82 X-2
2. (a) 10
(b) X-rays
(c) Accretion
(d) Supernova
(e) Accept anything ≥ 5 Solar masses
3. (a) 11
(b) 10^6 ($10^5 - 10^7$) miles per hour
(c) 10^8 ($10^7 - 10^9$) degrees Fahrenheit
(d) Star formation
4. (a) 4
(b) Galaxies
(c) Star
(d) Jets of high-energy particles from a black hole
(e) SPT-CLJ2344-4243
5. (a) 12
(b) Radio
(c) Galaxy
(d) 10^{10} ($10^9 - 10^{11}$) light years
(e) Star formation
6. (a) 47 Tucanae
(b) Globular cluster
(c) Old, edge
(d) RR Lyrae
(e) X9
- (f) Minutes
7. (a) 8
(b) X-ray
(c) NGC 1128, Abell 400
(d) Galactic merger
(e) Black holes
8. (a) 13
(b) Black holes
(c) $16/60 = 0.26$ (0.2-0.3) degrees
9. (a) 14
(b) Lenticular
(c) Gravitational waves
(d) Both gravitational and electromagnetic waves seen
10. (a) 7
(b) Galactic collision/merger
(c) Tidal forces between galaxies
11. (a) 6
(b) Supermassive black hole
(c) Sgr A*
12. (a) 5
(b) X-ray
(c) Supermassive black hole
(d) Galactic merger/collision
13. (a) 9
(b) Spiral
(c) Infrared
(d) Near the center

Team name: _____ KEY _____ Team number: _____ KEY _____

Answer Page: Section B (2 points each)

14. (a) 50 parsecs
(b) 7.5 - 9.1
(c) 2
(d) 16.5 - 20 years
(e) 0.05-0.5 milli-arcseconds
15. (a) -4.5 - -5.5
(b) 25 - 35
(c) 65 - 85 kilometers per second
(d) 65 - 85 kilometers per second per megaparsec
16. (a) 41 (40-42) kg
(b) -2 (-1 to -3) stars per parsec
(c) 8 (7-9) years
(d) 10 (9-11) years
(e) 9 (8-10) parsecs

Use the bottom of the page as extra space to write answers: