2017 New Jersey Science Olympiad Union County College Regional

Cranford, New Jersey Tuesday, January 10th, 2017



School Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Team Number (if applicable): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Event Session: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Welcome! If you want to master your Astronomy skills, you’ve come to the right place! Remember however, to 1) don’t cheat 2) get as many points as possible (each letter part is 1 point) and 3) remember to have fun. Astronomy rules! (Also, you can receive 1 point off per scientist you can name in the front and 2 additional points off for the reason why they’re important!)

Part 1: Deep Sky Objects

Use Image Set A for the following questions.

* 1. Name the object located in Image 1.
  2. Give the name of the object in the center of Image 1 and will our Sun become one in the future? (Can get half credit for either part)
  3. Scientists have detected unusually high levels of X-ray emission in the object in Image 1 compared to other similar stars. What do scientists deduce is the reason for the high emission?

1. Give the number of the image that shows Sirius A & B.
2. Give the numbers of the images that contain two white dwarfs orbiting each other.
3. Give the numbers of the images that contain globular clusters.
4. Give the numbers of the images that are Type Ia Supernovae?
5. (TB1)
   1. Give the number of the object that is called SS Cygni.
   2. Who discovered SS Cygni and in what year? (Can get half credit for either part)
   3. Cannizo (1993) suggested a factor as to be the reason whether an outburst is wide or narrow. What is that factor?
6. 1. Give the name of the object pictured in Image 5.
   2. What peculiarity explains the weird shapes of the rings and the nebulae itself?
7. 1. Give the number of the object that shows SNR 0509-67.5.
   2. In what galaxy is SNR 0509-67.5?
   3. Explain the mechanism that is occurring that causes the glowing pink optical shell to be formed?
8. 1. Give the name of the object located in Image 4.
   2. What constellation is this object located in?
   3. What is the general name for the clouds of dust and gas surrounding the central object?
9. 1. Give the number of the image that contains the progenitor of the Mira variable star.
   2. Name one other name for Mira.
   3. What stage of stellar evolution is Mira in right now?
10. (TB2) Give the name of the Deep Sky Object located in the Pinwheel Galaxy and known for being one of the youngest and closest Type Ia Supernovae.
11. 1. Give the number of the image that shows M15.
    2. What is another name for M15?
    3. What kind of object is Pease 1 inside M15?
12. 1. An artist’s depiction of an AM CVn star system evolving from its progenitor is shown in an image. Name the number of that image.
    2. What is the name of that system?
    3. Neither star of the system was shown to be a neutron star because what type of light was NOT detected?
    4. Give the number of the image that shows SNR G1.9+0.3.
    5. What constellation is it located in?
    6. Prior to this object’s discovery, what was the youngest-known Milky Way supernova remnant?
13. 1. What object is pictured in Image 9?
    2. What is another name for this object?
    3. What mission discovered the 321.5 modulation of the object in 1999?

Part 2: General Knowledge

Use Image B1 for Questions 1-7

1. Which path of stellar evolution is possible? (A) 2, 5, 6, 13, 10 (B) 3, 6, 5, 7, 9 (C) 4, 6, 8, 4, 9
2. What number would our Sun be located?
3. What number would white dwarfs be located?
4. Right or Left: In which direction on the HR Diagram do main-sequence stars move throughout their lifetime?
5. What letter would the supergiant branch be located?
6. What number would the Mira variable stars be located?
7. What letter would the asymptotic giant branch be located?
8. What types of waves do binary white dwarves give off, what important scientific theory do the waves contribute to the proving of? (Can get credit for either part)
9. A star has its strongest spectral lines in ionized helium and ionized hydrogen. (A) What spectral type is it most likely to be? (B) Is this star likely to be a white dwarf in the future?
10. What is one of the causes of the pulsations in Mira variable stars?
11. What type of object is the main object in AM CVn star systems?
12. (TB3) What is the timescale of the decay of nickel into copper in the aftermath of Type Ia Supernovae? (A) 6 days (b) 10 days (C) 16 days (D) 24 days (E) 30 days
13. What element can be detected in Type II Supernovae that can NOT be detected in Type Ia Supernovae?
14. What process in the core of a star allows for helium to be transformed into carbon? (A) proton-proton chain (B) Kelvin-Helmholtz reaction (C) free-fall reaction (D) gravitational contraction (E) triple-alpha reaction
15. (TB4) Give the name for the point at which material from a neighboring star pours over into the main star, causing accretion to occur.

Part 3: Term Identification

Match the description to the term.

1. The upper limit of the mass of a white dwarf.
2. The process in which the luminosity of a star rapidly increases coinciding with the start of fusion from helium into carbon.
3. The aftermath of a low-mass main-sequence star.
4. The force that allows the answer to Question 3 to stay intact.
5. (TB5)The process by which helium from the core will rise up to the photosphere and lithium from the surface will go back down to the core.
6. Stars shrouded in optically thick dust clouds radiating their energy primarily in infrared.
7. The stellar timescale prominent in the subgiant branch of stellar evolution.
8. A process that occurs as the white dwarf cools that starts in the center and moves outward.
9. The time in post-main-sequence evolution in which helium is burning in the core of a star.
10. An occurrence in which mass from the accretion disk of a white dwarf falls on the surface causing a rapid outburst of energy.
11. Chandrasekhar limit
12. Helium flash
13. White dwarf
14. Red giant
15. Type Ia Supernova
16. Electron degeneracy pressure
17. Kelvin-Helmholtz
18. Convection
19. Radiation
20. Subgiant
21. Horizontal branch
22. Asymptotic giant branch
23. Black dwarf
24. Dredge-up
25. OH/IR sources
26. Crystallization
27. Dwarf nova
28. Black hole

Part 4: Math

Remember, units count!!!!!(All answers have an acceptable error of 1%)

1. A star is detected to have a parallax of 0.05”. Give the distance of that star in parsecs.
2. If a star has an absolute magnitude of 3.00 and a distance of 5 parsecs, give its apparent magnitude to the nearest hundredth.

(TB3)

1. Two white dwarves, White Dwarf 1 and White Dwarf 2, are orbiting each other in a binary star system with the period of the orbit being 50 days and the sum of the semimajor axes being 2 AU. (A) Give the sum of the masses of the white dwarves in kg. (B) Given that the mass of White Dwarf 1 is 1 solar mass and the semimajor axis length of White Dwarf 1 is 1 AU, give the semimajor axis length of White Dwarf 2. (C) Given the radii of White Dwarf 1 being 0.5 solar radii and White Dwarf 2 being 0.2 solar radii, give the densities of the two objects in grams per cubic centimeters. (D) Would it be possible for this system to exist in reality?
2. An object is found to have its spectral line for Element X at 4000 Angstroms while the wavelength of Element X at rest is 3900 Angstroms. (A) What is the object’s spectroscopic redshift?(B) Derive the Hubble constant from the redshift derived in part A given the distance to the object is 10 parsecs. (in units of meters/second/meters) (C) How old can you estimate the Universe to be to the nearest hundred million years? (D) Does this make sense considering the oldest known stars are 13 billion years old?
3. A star is found to have an apparent magnitude of -10.00. (A) This star is of spectral type O5. Calculate the approximate luminosity in solar luminosities. (B) Using the luminosity found in Part A, calculate the absolute magnitude of the star. (C) Calculate how far away the star is to the nearest parsec. (D) Given the fact that the smallest parallax angle resolution is 0.0001”, would it be possible to detect the supernova by parallax alone?

Part 5: Short Answer

Don’t worry, they don’t need to be too long. Just enough for me to be able to tell if the answer is right and wrong (About 2-3 sentences should suffice.)

1. Give the characteristic of Type Ia Supernovae that is important in distance calculations.
2. Why is hydrogen most prominent in the spectral profile of an A-type star?
3. Give a quick description of how white dwarves can stay intact despite not having the ability to fuse hydrogen into helium and helium into carbon.
4. How are low-mass main-sequence stars able to create elements heavier than carbon and oxygen shortly before they become planetary nebulae and later white dwarves?
5. Would it be possible to one day build a civilization on a white dwarf and what kind of modifications would be needed for human life to survive, if at all?

THE END. Congratulations! Pat yourself on the back; you did a great job!



Tiebreaker: Math questions, then 5 specific questions, then coin flip/rock paper scissors