

Reach For the Stars

SSSS 2020 Test



Team Name and Number: _____

Team Members: _____

Score: ____/165

You will have 50 minutes to complete this test.

Do not open this test before instructed to do so.

There are 3 parts to this test.

- Part 1: General Knowledge
- Part 2: ID Questions
- Part 3: Calculation Questions

Partial credit may be given in Parts 2 and 3 at the graders' discretion, but **NOT** in Part 1.

Good Luck! :)

Part 1: General Knowledge

Part Score: ___/37

Multiple Choice

The following section will consist of multiple choice questions. Each question will have *at least 1* correct answer. You must circle all correct answers. Each question is worth 1 point, and partial credit will *not* be given. Good luck! :)

1. What element will the Sun fuse in its next stage of evolution?
 - a. Hydrogen
 - b. Helium
 - c. Carbon
 - d. Oxygen

2. “Brightness”, in astrophysics, is best fit with the term:
 - a. Luminosity
 - b. Absolute Magnitude
 - c. Apparent Magnitude
 - d. Magnitude Variability

3. Which cluster type contains younger stars?
 - a. Open Cluster
 - b. Globular Cluster
 - c. Pleiades Cluster
 - d. Star-Formation Cluster

4. Which galaxy type contains the oldest stars?
 - a. Spiral
 - b. Barred Spiral
 - c. Elliptical
 - d. Irregular

5. On the stellar coordinate plane, what is the term describing the Sun’s apparent path in the night sky?
 - a. Celestial Equator
 - b. Celestial Meridian
 - c. Right Ascension
 - d. Ecliptic

6. Which of the following are variables shown on a typical H-R Diagram?
 - a. Luminosity
 - b. Apparent Magnitude
 - c. Absolute Magnitude
 - d. Temperature

7. Which of the following are considered “standard candles” in cosmology?
 - a. Cepheid Variables
 - b. Type Ic Supernovae
 - c. Type Ia Supernovae
 - d. T Tauri Stars

8. Which property of a celestial object can be measured from knowing its luminosity and its brightness?
 - a. Temperature
 - b. Size
 - c. Color
 - d. Distance from Earth

9. Which of the following stars is in the Winter Triangle asterism, but not the Winter Hexagon asterism?
 - a. Betelgeuse
 - b. Sirius
 - c. Procyon
 - d. Vega

10. Which Harvard spectral star type has the strongest hydrogen emission lines?
 - a. Type O
 - b. Type A
 - c. Type G
 - d. Type M

11. Wolf-Rayet stars have very weak hydrogen emission lines, yet they are not metallic. Based on this information, what can be best inferred about these stars?
 - a. They are Type O stars.
 - b. They are red in color.
 - c. They are rapidly losing mass.
 - d. They eventually collapse, leaving behind a neutron star.

12. Which of the following is *not* true of population II stars?
 - a. They are metal-poor.
 - b. They are more present in HII regions than in HI regions.
 - c. They are older than population I stars.
 - d. They are present in globular clusters.

13. Case: A new nebula, Nebula X, has been recently discovered. It is shaped like a ring, a ring of dust. However, scientists hypothesize that there may be a star cluster in the center of the ring, obscured from view. Which major telescope should these scientists use to peer through this ring of dust?
 - a. Hubble Space Telescope
 - b. Chandra X-Ray Observatory
 - c. Spitzer Infrared Telescope
 - d. Very Large Array

14. Case: Star Y has a surface temperature of 22,000°K. Based on this, what is its Harvard spectral type?
- Type O
 - Type B
 - Type A
 - Type F
15. The Balmer series documents the emission lines of which element?
- Hydrogen
 - Helium
 - Oxygen
 - Neon
16. What is the term for the angular distance (North/South) an object is from the celestial equator?
- Right Ascension
 - Declination
 - Azimuth
 - Zenith
17. What is the term for the upper bound to the mass of neutron stars?
- Chandrasekhar Limit
 - TOV Limit
 - Hubble's Limit
 - Eddington Limit
18. What is the process of fusion for main-sequence stars under 1 solar mass?
- CNO Cycle
 - Deuterium Fusion
 - Triple-alpha Process
 - Proton-proton Chain
19. Which of the following properties of a star can be determined by viewing its spectra over time?
- Temperature
 - Evolutionary Stage
 - Composition
 - Luminosity

For question #20, refer to Image Sheet B.

20. Case: Star Y is being closely studied via its light curve, shown in Image 1. Based on this light curve, what can be said about this star?
- It is actually a spectroscopic binary star system.
 - It is actually an eclipsing binary system.
 - It is a Cepheid variable star.
 - It is an RR Lyrae variable star.

Free Response

The following section will consist of free response questions. Answer all questions to the best of your ability. Each question is worth a specified number of points, and partial credit will *not* given. Refer to Image Sheet B for these questions. Good luck! :)

1. What is the general difference between Type I and Type II supernovae? (2 points)

2. On Image 2, which star (on this year's rules) is denoted by...
 - a. A? (1 point) _____
 - b. B? (1 point) _____
 - c. C? (1 point) _____
 - d. D? (1 point) _____

3. What keeps white dwarfs from collapsing? (1 point)

4. What keeps neutron stars from collapsing? (1 point)

5. Name one unique use of observing in each of the following wavelengths:
 - a. Radio (1 point):

 - b. X-Ray (1 point):

 - c. Infrared (1 point):

6. Using the Hubble Classification System, classify the galaxy denoted by:
 - a. Image 3 (1 point): _____
 - b. Image 4 (1 point): _____
 - c. Image 5 (1 point): _____
 - d. Image 6 (1 point): _____

7. Name the nucleosynthesis process detailed in Image 7. (1 point)

8. Name the other nucleosynthesis process present in some main-sequence stars. (1 point)

Part 2: ID Questions

Part Score: ___/82

DSOs

You will need to use Image Sheets 1 and 2 for Part 2.

1. What DSO is depicted on the cover of this test? Which images on Image Sheet 1 are of the same DSO? What wavelengths are the images in? Explain how you know what wavelength each image is in. (5 points)

2. What DSO is Image B? What are the two “spokes” coming out of the galaxy? What causes these “spokes” to form? (3 points)

3. Which images on Image Sheet 1 are of H II regions? What is an H II region? What type of object are H II regions commonly found in? (4 points)

4. What is depicted in Image J? What DSO is this a part of? What other image shows the same DSO? (3 points)

5. What 2 DSOs are depicted in Image L on the left and right, respectively? What are the blue circles around stars? What is the DSO to the left often associated with? (4 points)

6. Image E is the farthest galaxy we know of to date. What does this tell us about its age and redshift? Explain your answer for both age and redshift. Image E's distance from the Earth is actually 32 billion light years. How is this possible given that the age of the universe is 13.8 billion years? What DSO is Image E? (7 points)

7. Identify which two images on Image Sheet 1 are stars. One of said stars is Zeta Ophiuchi. What is the arc going around Zeta Ophiuchi and how does it form? What wavelength length is the image of Zeta Ophiuchi in? The other of said stars is T Tauri. Where on the HR diagram would one find a T Tauri star? How does a T Tauri star get its energy? How can one identify a T Tauri star based on its spectra? Why does spectral identification for T Tauri stars work? (7 points)

8. What DSOs are found in the constellation in Image C? What is happening to the two galaxies? Describe what is happening to the dark matter in the galaxies. What do these observations of dark matter say about dark matter? (6 points)

9. What DSO is Image T? Which image is Image T in? Based on star formation, what type of galaxy is Image T? Why is this DSO able to be studied in infrared but not optical? (5 points)

10. What DSO is depicted in Image V? What is the arrow in Image V pointing to? What image is Image V in? There are actually 3 parts to this object. Name said parts and explain what they all are. What is significant about this object? (6 points)

Star Chart

The image below is a star chart. This star chart as well as Image Sheet 1 will be used to answer questions 11-18. The numbers refer to constellations and the letters refer to stars.



11. What constellation does 1 point to? What image on Image Sheet 1 is of the same constellation? What images on Image Sheet 1 are of DSOs in 1? Identify the DSOs in said images. (4 points)

12. What constellation does 2 point to? What image on Image Sheet 1 is of the same constellation? What image on Image Sheet 1 is of a DSO in 2? Identify the DSO in said image. (4 points)

13. What constellation does 3 point to? What DSO on the rules is in this constellation? What image on Image Sheet 1 depicts this DSO? (3 points)

14. What constellation does 4 point to? What image on Image Sheet 1 is a DSO in 4? What type of wavelength was the said image taken in? This galaxy is going to collide with another galaxy eventually, what type of galaxy will it turn into as a result of the collision? (4 points)

15. What constellation does 5 point to? What star does c point to? Which part of the HR Diagram would this star be a part of? This star is part of a famous asterism, what is the name of said asterism and what are the other 2 stars in the asterism? (5 points)

16. What constellation does 6 point to? In this constellation there is the Large Magellanic Cloud. What type of galaxy is the Large Magellanic Cloud? How did the Large Magellanic Cloud's structure get warped? (4 points)

17. What constellation does 7 point to? What star does b point to? This star is not spherical, why is this so? How will this star die? (4 points)

18. What constellation does 8 point to? What star does a point to? What is this star's Yerkes luminosity class? What type of supernova will this star produce? (4 points)

Part 3: Calculation Questions

Part Score: ___/46

The following section will consist of free-response calculation questions. All work must be shown and justified (where applicable) to receive full credit. Partial credit may be given. Good Luck! :)

Constants That May Be Useful:

$$b = 2.898 * 10^{-3} \text{ m-K}$$

$$L_0 = 3.0128 * 10^{28} \text{ W}$$

$$L_{\odot} = 3.827 * 10^{26} \text{ W}$$

$$M_{\text{Ia}} = -19.5$$

$$\sigma = 5.6704 * 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$$

$$t_v = 9602^{\circ} \text{K}$$

1. If the Sun's temperature were to increase tenfold, and its radius were to increase by a scale factor of 3, by what scale factor would its luminosity have to increase? (6 points)

2. Case: Star A and Star B have bolometric magnitudes of +1.45 and -0.43, respectively. Based on this, how many times more luminous is Star B than Star A? (10 points)

