



Exploring the World of Science

Practice Exam 2
Summer 2020
Division B – Reach for the Stars

Team Name: _____

Team Number: _____

Competitor Names: _____

Ensure that you have been provided with an exam, image sheets, and answer sheet.

Each question is worth the number of points specified in parentheses next to the question number.

In the event of a tie, score in the following sections may be used as tiebreakers, in order: Section 2, Section 3, Section 4, Section 1.

Good luck, and may the stars be with you!

Section A: Refer to Image Set A to answer Questions 1-15

On August 21, 2017, a total solar eclipse passed through the continental United States, including over the small town of Adams, Tennessee, about 45 minutes north of Nashville. Image 1 depicts the orientation of the stars in the Adams sky at time of totality (note that only the brightest stars would have been visible, even under the total eclipse). Image 2 depicts the sky over the French island of Ile Amsterdam in the Indian Ocean at the same time and date, nearly directly opposite of Adams on the Earth.

For each object in Questions 1-15, identify the constellation it is a part of and which number it is indicated by on Image 1 or 2.

- | | |
|-------------------------------|--------------------|
| 1. (2) Arcturus | 9. (2) Rigel |
| 2. (2) Altair | 10. (2) Capella |
| 3. (2) Baby Boom Galaxy | 11. (2) NGC 6334 |
| 4. (2) Antares | 12. (2) Wolfe Disk |
| 5. (2) Large Magellanic Cloud | 13. (2) M60 |
| 6. (2) Deneb | 14. (2) Pollux |
| 7. (2) Small Magellanic Cloud | 15. (2) NGC 5128 |
| 8. (2) Algol | |

Section B: Refer to Image Set B to answer Questions 16-25

16. The Antennae Galaxies are a set of colliding galaxies first observed in 1785
- (2) Which image depicts these galaxies mid-collision? What wavelength was this image taken in?
 - (1) What constituent materials were found in observations in this wavelength?
 - (1) Why was this observation important in the context of our own Solar System?
 - (1) How might further observations of this object (in this wavelength or others) be important in the context of our galaxy as a whole?
17. Image 7 depicts the star in our night sky with the lowest apparent magnitude
- (1) What constellation is this star a part of?
 - (2) How will this star's apparent magnitude change over the next hundred thousand years? How will its absolute magnitude change in the same time?
 - (1) What does this imply about this star's position relative to the Sun?
18. GN-z11 is an extremely high-redshift galaxy, at $z=11.09$
- (1) Which image depicts this galaxy as observed by the Hubble Space Telescope?
 - (2) To what distance does this redshift value correspond to? How does this differ from the actual age of the galaxy as perceived by Hubble?
 - (1) How does GN-z11 challenge our current understanding of the early universe?
19. Image 5 depicts one of the most extensively studied stars in the night sky
- (2) What is the name of this star, and what wavelength was this image taken in?
 - (1) Observations in this wavelength established this star as the prototype of any star exhibiting what characteristic?
20. One of the minor objects in Image 4 is often designated as an "Ultra-Compact Dwarf Galaxy", abbreviated as "UCD"
- (1) Which telescope was used to take Image 4?
 - (2) What is the name of the major object shown in this object? What is the UCD's spatial relationship to this major object?
 - (2) Observations by the telescope used to take this image show what unexpected activity in the UCD? This implies the existence of what feature?
 - (1) What process earlier in this object's life may have resulted in this observation?

21. An Algol variable is a type of eclipsing binary named for its prototype, Algol
- (1) Which image depicts this prototype in infrared?
 - (2) Describe the mechanism by which a variable of this class changes in brightness? Be as specific as needed to distinguish from other variables like it.
22. Ophiuchus is a constellation easily visible during Northern hemisphere summers
- (1) Which image depicts the major dark nebula found in Ophiuchus in infrared?
 - (2) What major stellar process is occurring within this nebula? This is primarily confirmed by observations in what wavelength?
 - (1) This nebula is often seen in the night sky overlapped by what red supergiant?
 - (1) Which image depicts this star?
23. Image 6 depicts a member of the subclass of galaxies known as a radio galaxy
- (1) What is the New General Catalogue number of this galaxy?
 - (1) What feature of the galaxy is shown in this particular radio observation?
 - (1) This feature suggests what event occurring in this galaxy's recent past?
24. Alpha Orionis is usually one of the brightest stars in the night sky. However, for at least the early months of 2020, this was not the case
- (1) Which image depicts this star during this brief dimming period?
 - (1) What major astronomical event could this dimming have preceded?
 - (2) How has this star's brightness changed since this initial dimming? What does this suggest about the true source of the dimming?
25. The Andromeda Galaxy, our nearest major galactic neighbor, has been extensively imaged in the x-ray wavelength region by the Chandra telescope
- (1) Which image depicts this galaxy as imaged by Chandra?
 - (2) What portion of the galaxy is shown in this image? What unique features are highlighted by specifically observing this portion in x-ray?

Section C: Refer to Image Set C to answer Questions 26-30

26. For each star below, give the letter on the H-R Diagram (Image 1) that best corresponds to its stage of evolution. Letters may be used once, more than once, or not at all

- a. (1) Aldebaran
- b. (1) Spica
- c. (1) Polaris B
- d. (1) Zeta Ophiuchi
- e. (1) Alcor B
- f. (1) T Tauri
- g. (1) Sirius B
- h. (1) Castor Ba

27. For each galaxy below, give the letter on the Hubble – de Vaucouleurs Diagram (Image 2) that best corresponds to its morphology. Letters may be used once, more than once, or not at all

- a. (1) Messier 31
- b. (1) Messier 60
- c. (1) Messier 101
- d. (1) Centaurus A
- e. (1) Large Magellanic Cloud
- f. (1) Small Magellanic Cloud
- g. (1) NGC 4555
- h. (1) GN-z11

28. (5) Based on the magnitudes given below, order each star by distance (near to far):

- **Star A:** Absolute magnitude = +3.0; Apparent magnitude = -1.0
- **Star B:** Absolute magnitude = +3.0; Apparent magnitude = +4.0
- **Star C:** Absolute magnitude = +4.0; Apparent magnitude = -1.0
- **Star D:** Absolute magnitude = -2.0; Apparent magnitude = -6.0
- **Star E:** Absolute magnitude = -2.0; Apparent magnitude = +4.0

29. (5) Based on the set of stellar spectra and corresponding letters given in Image 3, order the following spectra by appearance in a Sun-like star's lifetime, from zero-age main sequence to death in a planetary nebula: **B, F, G, H, J**

30. For each of the changing values given below, and assuming all else remains constant, state what factor the given parameter of a perfect blackbody would increase or decrease by:

- a. (1) Change in luminosity as radius triples
- b. (1) Change in radius as temperature halves
- c. (2) Change in luminosity as peak wavelength doubles

Section D: For each description given in Questions 31-40, give the general astronomical term or phenomenon it acts as the description of

31. (1) Distance unit corresponding to a parallactic shift of 1 arcsecond
32. (1) Stellar classification scheme by luminosity derived from spectral lines
33. (1) Cluster diagram feature representing the rapid stage of evolution between main sequence and red giant stars
34. (1) Type of active galaxy where the host galaxy is clearly discernible
35. (1) Brief, carbon-producing runaway process which occurs during the red giant phase for low-mass stars
36. (1) Stellar cluster often containing old stars around a galaxy's halo
37. (1) The center of mass around which two or more celestial bodies orbit
38. (1) Idealized body which absorbs all incident radiation across the entire EM spectrum
39. (1) Type of active galaxy with significant and rapid variability in luminosity
40. (1) Apparent dimming or brightening of luminous matter at near-light velocity