Exploring the World of Science

Practice Exam 1
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 point 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 1.

Good luck, and may the stars be with you!

Section A: Please refer to Image Set A to answer Questions 1-20

For Questions 1-10, name the constellation containing each star and which letter on Image 1 best matches its H-R Diagram location. Letters may be used once, more than once, or not at all.

1. (2) Sirius B
2. (2) Rigel A
3. (2) Antares
4. (2) Capella H
5. (2) Mizar
6. (2) Procyon A
7. (2) Spica
8. (2) Deneb
9. (2) Aldebaran
10. (2) Castor A

For Questions 11-20, name the constellation containing each galaxy and which letter on Image 2 best matches its Hubble sequence type. Letters may be used once, more than once, or not at all. For galaxies of unclear morphology, multiple answers are acceptable.

11. (2) Messier 104
12. (2) NGC 5128
13. (2) Baby Boom Galaxy
14. (2) Messier 60
15. (2) Small Magellanic Cloud
16. (2) Messier 101
17. (2) Large Magellanic Cloud
18. (2) GN-z11
19. (2) Messier 31
20. (2) NGC 4676A

Section B: Refer to Image Set B to answer Questions 21-30.

21. M42 is a large diffuse nebula in the constellation Orion.
    a. (1) Which image depicts M42?
    b. (1) M42 is so named because it appeared in the first catalogue published by which French astronomer in 1771?
    c. (1) M42 is notable for being the site of what major stellar process?

22. Vega is an A-type star, the brightest in the constellation Lyra.
    a. (1) What is the Bayer designation of Vega?
    b. (1) Which image depicts this star?
    c. (2) What wavelength is this image taken in, and how does this affect its appearance in the image?
    d. (2) What structure of Vega is visible through observations in this wavelength, and what can it tell us about our own solar system?

23. Image 10 depicts the red giant star often called the "Heart of the Scorpion".
    a. (1) What is the name of this star?
    b. (1) This star has been observed to vary in brightness over time with long-scale, unpredictable periodicity. This classifies it as what type of variable star?
    c. (1) This star exists as a member of a binary system, with Image 10 depicting the primary component. What type of object is the secondary component?
    d. (2) Exactly one other image depicts an object which shares a constellation with the star in Image 10. What is the name and image number of this object?
    e. (2) What wavelength is this image taken in, and what do observations in this wavelength reveal about this object?

24. (6) Order the objects in the following images from earliest to latest stage of evolution: Image 2, 8 (primary object), 8 (secondary object), 10, 12, 14

25. As referenced in Question 24, Image 8 depicts a star system with two components.
    a. (1) What is the name of this star system?
    b. (1) Which of these components will the Sun most resemble in 10 billion years?
    c. (1) At initial formation, which component was more massive?
    d. (1) How will this system be different in 10 billion years?

26. Image 1 depicts an elliptical galaxy in the Virgo cluster.
    a. (1) What wavelength was this image taken in?
    b. (2) Which image depicts this same object in a different wavelength? What wavelength was this image taken in?
    c. (1) What major object is revealed by observations in the Image 1 wavelength?
    d. (1) What is significant about the above referenced object?

27. Centaurus A is a starburst galaxy of ill-defined morphology.
    a. (2) Which image depicts this galaxy? In what wavelength is it depicted?
    b. (2) What structure can be seen in this wavelength, and what other wavelength might this same structure be visible in?
    c. (1) What structure is NOT visible in this wavelength, but which contributes to Cen A's ambiguous morphology?

28. Image 9 depicts activity in the nearest major galaxy to the Milky Way
    a. (1) What is the Messier catalogue number of this galaxy?
    b. (2) The six divisions of this image each represents a cluster of stars. Structurally, in what way do these clusters differ and in what way are they the same?
    c. (1) What is the anticipated fate of this galaxy 5 billion years from now?

29. Sagittarius A* is the ultra-bright radio source at the center of our galaxy
    a. (2) Which image depicts this object? What wavelength was this image taken in?
    b. (2) What type of object is Sagittarius A*, and how does it differ from other objects of its type within a Seyfert galaxy (which the Milky Way is not)?

30. Image 12 depicts a young star and its surrounding environment

a. (1) What class of stars is this object prototypical of?

b. (1) What is the name of the crescent-shaped cloud surrounding this object?

c. (2) Between what two phases of a star's life will it resemble this object?

d. (2) What have radio observations revealed about the current location of this object? What has most likely caused this to happen?

Section C: Refer to Image Set C to answer Questions 31 & 32.

31. Image 1 displays the blackbody emission spectra of 5 different stars

a. (1) Which of these lines corresponds to the hottest star?

b. (1) Given equal luminosity, which of these lines corresponds to the largest star?

c. (2) If the radius of the largest star were doubled, how would its luminosity change? If the temperature of the hottest star were halved, how would its luminosity change?

32. Image 2 shows the H-R Diagram distribution of the brightest stars in two galaxies within the Local Group. Stars filled in black (such as Star A) are from one of these galaxies, with stars filled in white (such as Star B) from the other. Each star's apparent magnitude is given on the left-hand y-axis, with the absolute magnitude on the right.

a. (1) Which star (A vs B) is brighter in the night sky?

b. (1) Which star is more luminous?

c. (1) Which star would best approximate Beta Orionis, were it in the same galaxy?

d. (3) How far away is Star A? Star B?

Extra Credit (2): Which two galaxies are being depicted by Image 2?