Reach for the Stars

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Practice Test

2020-2021 Season

Answer Key

Information

- This exam contains 6 parts, 79 questions, and 180 points total.
- You may take this test apart. Put your team number on each page. There is not a separate answer page, so write all answers on this exam.
- You are permitted the resources specified on the 2021 rules.
- Don't worry about significant figures, use 3 or more in your answers. However, be sure your answer is in the correct units.
- For calculation questions, any answers within $\pm 10\%$ (inclusive) of the answer on the key will be accepted.
- Ties will be broken by section score in reverse order (i.e. Section F score is the first tiebreaker, Section A the last).
- Written by RiverWalker88. Feel free to PM me if you have any questions, feedback, etc.
- Good Luck! Reach for the stars!

Constants and Conversions

CONSTANTS

Stefan-Boltzmann Constant $= \sigma = 5.67 \times 10^{-8}\ W/m^2K^4$
Speed of light $= c = 3 \times 10^8 \text{m/s}$
Mass of the sun $= M_{\odot} = 1.99 \times 10^{30} \text{kg}$
Radius of the sun $= R_{\odot} = 6.96 \times 10^5 \text{km}$
Temperature of the sun $= T_{\odot} = 5778 \text{K}$
Luminosity of the sun $= L_{\odot} = 3.9 \times 10^{26} \text{W}$
Absolute Magnitude of the sun $= M_{V\odot} = 4.83$

UNIT CONVERSIONS

1 AU $= 1.5 \times 10^6 \text{km}$
1 ly $= 9.46 \times 10^{12} \text{km}$
1 pc $= 3.09 \times 10^{13} \text{km} = 3.26$ ly
1 year $= 31557600$ seconds

USEFUL EQUATIONS

Wien's Law: $\lambda_{peak} = \dfrac{2900000}{T}$

- $T =$ Temperature (K)
- $\lambda_{peak} =$ Peak Wavelength in Blackbody Spectrum (nanometers)

Parallax: $d = \dfrac{1}{p}$

- $d =$ Distance (pc)
- $p =$ Parallax Angle (arcseconds)

Part A: Astrophotographical References
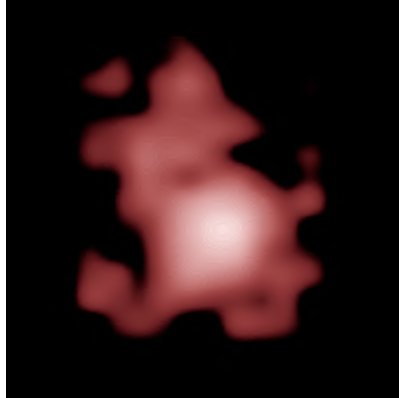
9 questions, 18 points total

For each of the following, identify the star or deep space object pictured in the image. Each is worth 2 points.

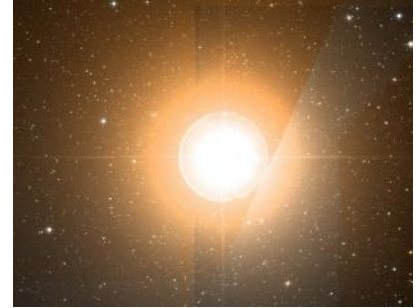1. Optical wavelength image.

NGC 1333

2. Infrared wavelength image.

GN-Z11

3. Optical wavelength image.

Betelgeuse

4. Optical wavelength image.

NGC 5128

5. Optical wavelength image.

Small Magellanic Cloud

6. False-color optical wavelength image.

T Tauri

7. Optical wavelength image.

NGC 4555

8. Optical wavelength image.

Messier 8

9. An artist's impression.

DLA 0817g

# Part B: Fascinating, Notable Object Features

18 questions, 26 points total

10. (1 point) Which of the following stars is a variable star with rapid pulsations and small, irregular light curve amplitudes?

    A. T Tauri

    B. Deneb

    C. Vega

    D. Zeta Ophiuchi

11. (1 point) Which of the following DSOs contains an inactive supermassive black hole?

    A. Large Magellanic Cloud

    B. NGC 5128

    C. NGC 1333

    D. M60

12. (1 point) Which of the following DSOs has the highest rate of star formation?

    A. Baby Boom Galaxy

    B. NGC 6334

    C. M101

    D. M31

13. (1 point) Which of the following is a "compact radio source"?

    A. Sirius

    B. Altair

    C. Small Magellanic Cloud

    D. Sgr A*

14. (1 point) The first brown dwarf ever to be identified in a star-forming region was found in which of the following objects?

    A. Rho Ophiuchi Cloud Complex

    B. Small Magellanic Cloud

    C. Large Magellanic Cloud

    D. Messier 8

15. (1 point) Which of the following objects is a binary system with high orbital ellipticity and asynchronized periods of the component stars?

    A. Vega

    B. Spica

    C. Sirius

    D. Betelgeuse

16. (2 points) Which object on specified in the rules manual is unusually luminous in the X-Ray wavelength, 40 light years away, and contains evidence of the presence of the elements magnesium, neon, and iron?
Capella

17. (2 points) Which object specified in the rules manual contains a massive, heavily active star-forming regions, with stellar winds, supernovae that cause shock waves, has been heated to millions of degrees, and contains one of the brightest X-Ray sources (Melnick 34)?
30 Doradus

18. (2 points) Which object specified in the rules manual contains a hot central blue star, tornado-like twisting structures caused by mixing of hot and cold in the clouds, and contains Bok globules.
Messier 8

19. (1 point) The clouds around the dragonfish nebula are emitting unusally more waves of which wavelength in comparison to similar objects.

    A. Radio

    B. Ultraviolet

    C. Gamma

    D. Microwave

20. (1 point) What type of galaxy is M104?

    A. Spiral

    B. Lenticular

    C. Irregular

    D. Elliptical

21. (1 point) Vega will likely become the Earth's north star again in about how many years?

    A. 3,000

    B. 12,000

    C. 1.3 million

    D. It will never become the north star.

22. (1 point) What type of galaxy is NGC 4308?

    A. Spiral

    B. Barred Spiral

    C. Irregular

    D. Elliptical

23. (1 point) Which of the following light curves matches that of T Tauri? Correct Answer: D
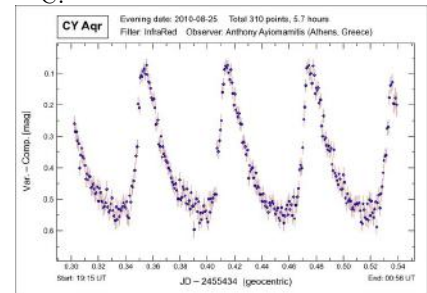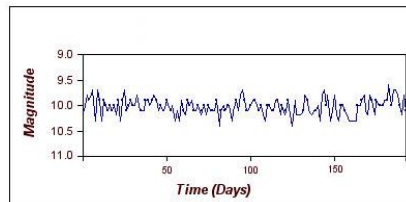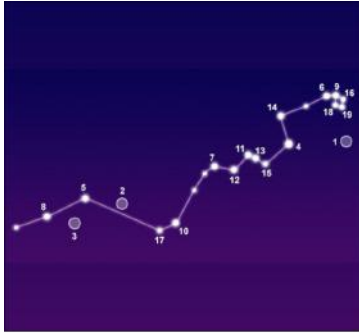
A.
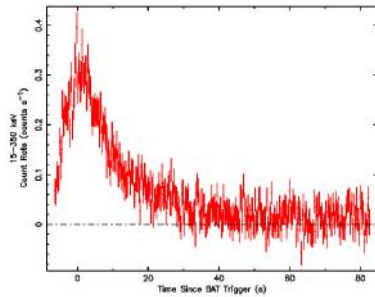
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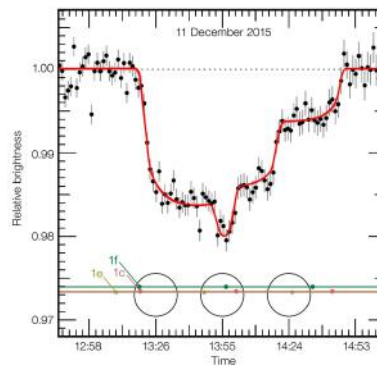
C.

D.

24. (a) (2 points) DLA0817g was discovered by what instrument?
    Atcama Large Millimeter Array (or ALMA works too)

   (b) (2 points) About how long after the Big Bang did this galaxy form?
    Approximately 1.5 billion years

25. (3 points) Why does Zeta Ophiuchi appear as a dim red star in visible light, but a hot, blue star in infrared?
    It is pushing its way through significant interstellar dust, which is obscuring a lot of its blue light.

26. (2 points) What is the period of Algol?
    20 hours, 49 minutes (Accept anywhere between 20 hours 30 minutes and 21 hours)
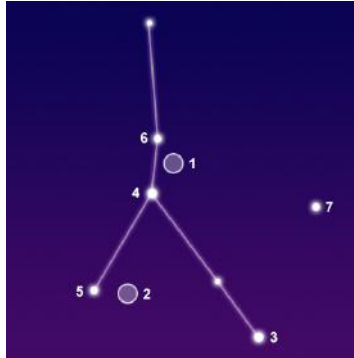
Part C: C is for Constellations
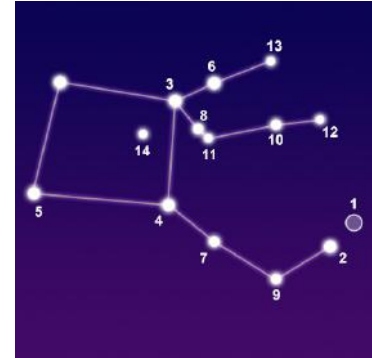10 questions, 19 points total

27. (1 point) Identify the constellation:

    A. Andromeda

    B. Leo

    C. Vela

    D. Hydra

28. (1 point) Identify the constellation:

    A. Lacerta

    B. Cancer

    C. Aries

    D. Caelum

29. (1 point) Identify the constellation:


    A. Pegasus

    B. Horologium

    C. Grus

    D. Fornax

30. (1 point) In the northern hemisphere, Indus is best viewed in which of the following seasons?

    A. Autumn

    B. Winter

    C. Spring

    D. Summer

31. (1 point) In the northern hemisphere, Carina is best viewed in which of the following seasons?

    A. Autumn

    B. Winter

    C. Spring

    D. Summer

32. (1 point) In the northern hemisphere, Orion is best viewed in which of the following seasons?

    A. Autumn

    B. Winter

    C. Spring

    D. Summer

33. (1 point) In the northern hemisphere, Lyra is best viewed in which of the following seasons?

    A. Autumn

    B. Winter

    C. Spring

    D. Summer

For each of the following star charts, identify the constellation pictured (1 point). Then, connect the necessary stars to form the constellation pictured (3 points).
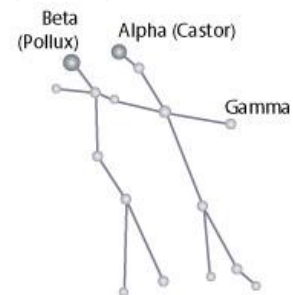
34. (4 points) Connect stars & identify.

Lynx

35. (4 points) Connect stars & identify.

Andromeda
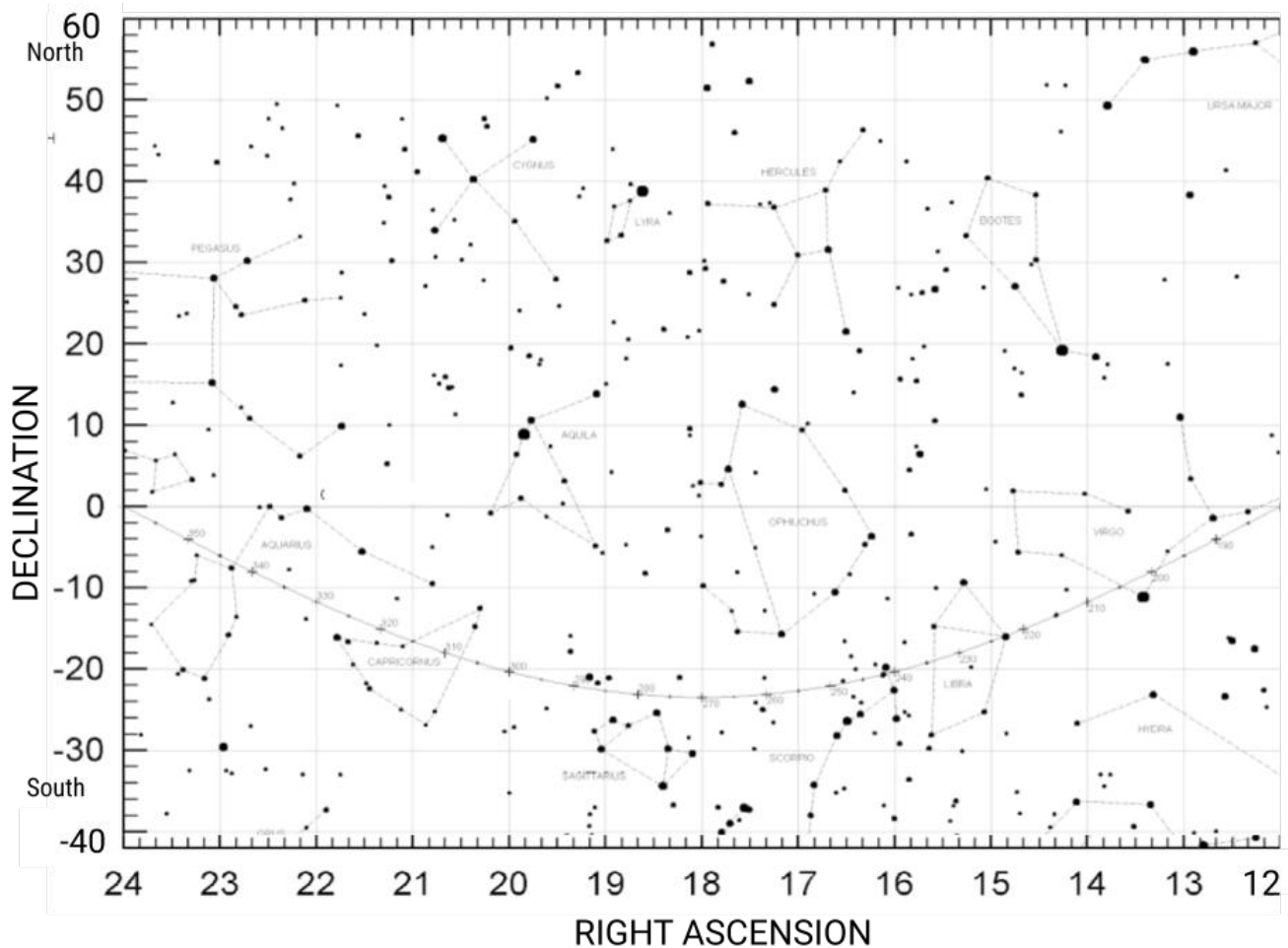
36. (4 points) Connect stars & identify.
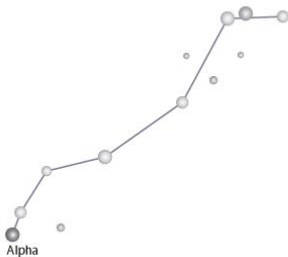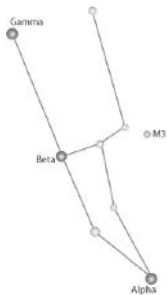
Gemini

FOR CONSTELLATION CONNECTION POINTS: Award full pts for up to one missing/incorrect connection. Half pts for two bad connections. Stars do not need to be labelled.

Part D: Sky Scholar
7 questions, 14 points total

Use the star chart below to answer the questions in this section.

37. (2 points) What is the line that crosses the diagram starting and ending at the middle and bending downward at the middle called?
    Ecliptic

38. (2 points) What is straight line that spans the diagram at a Declination of 0 called?
    Celestial Equator

39. (2 points) This map shows the sky that is seen from how much of Earth?
    One hemisphere, half of earth's surface, similar answers.

40. (2 points) What are the coordinates of Polaris on this map?
    13hr 48min +40° 48′

41. Find the star that lies at approximately 19hr 48min + 0° 54′.

    (a) (2 points) What constellation is this star in?
        Aquila

    (b) (2 points) Is this star closer to the celestial equator or the ecliptic?
        Celestial Equator

    (c) (2 points) How does this star's brightness compare to the brightness of the rest of the stars in the box formed by the coordinate plane it lies in?
        This star is the brightest star in the square formed by the coordinate grid.

Part E: Starry Night
25 questions, 67 points total

42. (1 point) Which of the following is an example of a star?

    A. Earth

    B. The Sun

    C. The Moon

    D. DLA 0817g

43. (1 point) Which of the following star masses will most likely form a planetary nebula?

    A. $0.25 \, M_\odot$

    B. $2.5 \, M_\odot$

    C. $25 \, M_\odot$

    D. $250 \, M_\odot$

44. (1 point) How will the mass of a red giant star compare with that of the young star that it was formed from?

    A. It will be more massive

    B. It will be less massive

    C. It will be equally massive

    D. It will be impossible to know without further observation.

45. (1 point) Which of the following is the remnant of the death of a star?

    A. Planet

    B. White Dwarf

    C. HII region

    D. Protostar

46. (1 point) Which of the following best describes a supernova?

    A. A massive explosion caused by the collision of two galaxies.

    B. An extremely bright explosion caused by aging stars.

    C. A large area of dust in the night sky, containing numerous emission nebulae and formation sites for young protostars.

    D. A small explosion caused by orbital debris that crosses planetary orbits.

47. (1 point) As stars get cooler, they contain:

    A. More heavy metal spectral lines

    B. Fewer heavy metal spectral lines

    C. More hydrogen spectral lines

    D. Fewer hydrogen spectral lines

48. (1 point) Which of the following is the best example of the use of observations in the ultraviolet wavelength.

    A. Mapping interstellar matter.

    B. Observing Hot White dwarf stars.

    C. Cooler objects, such as Red Dwarf Stars.

    D. Observing neutron star binary systems.

49. (3 points) Order the steps for the formation of a planetary nebula.

    i. The temperature increases so much that UV radiation ionizes the surrounding cloud.

    ii. The outer shells pulsate violently.

    iii. Inner carbon core stops generating energy, while the outer-core shells continue to burn hydrogen and helium.

    iv. The envelope expands and cools.

    v. The remainder contracts and heats up.

    vi. Series of helium-shell flashes begin.

iii, iv, vi, ii, v, i

50. (2 points) What chemical process powers stars?
    Nuclear fusion (Full Points for Proton-Proton Chain, CNO Cycle, and Triple-Alpha Process)

51. (2 points) If I look up at the sky tonight and see a star that has a reddish tint, what is the most likely evolutionary stage that this star is in?
    Red Giant

52. (2 points) Planetary nebulae considered relatively rare astronomical objects. What causes this?
    They are relatively short-lived objects, that diffuse after 20,000 years or so.

53. (3 points) How does the formation of a Type II Supernova compare with the formation of a Type Ia supernova?
    A type Ia supernova is caused by a white dwarf star erupting from excess mass accretion. A type II supernova is formed from a large star no longer producing enough energy to maintain a balance.

54. (2 points) What type of stars are in the spectral classes WN and WC?
    Wolf-Rayet Stars

55. (2 points) List the spectral classes in the order that they would be found on the X-Axis on an H-R Diagram.
    OBAFGKM

56. (6 points) Label this diagram of the internal structure of the sun.
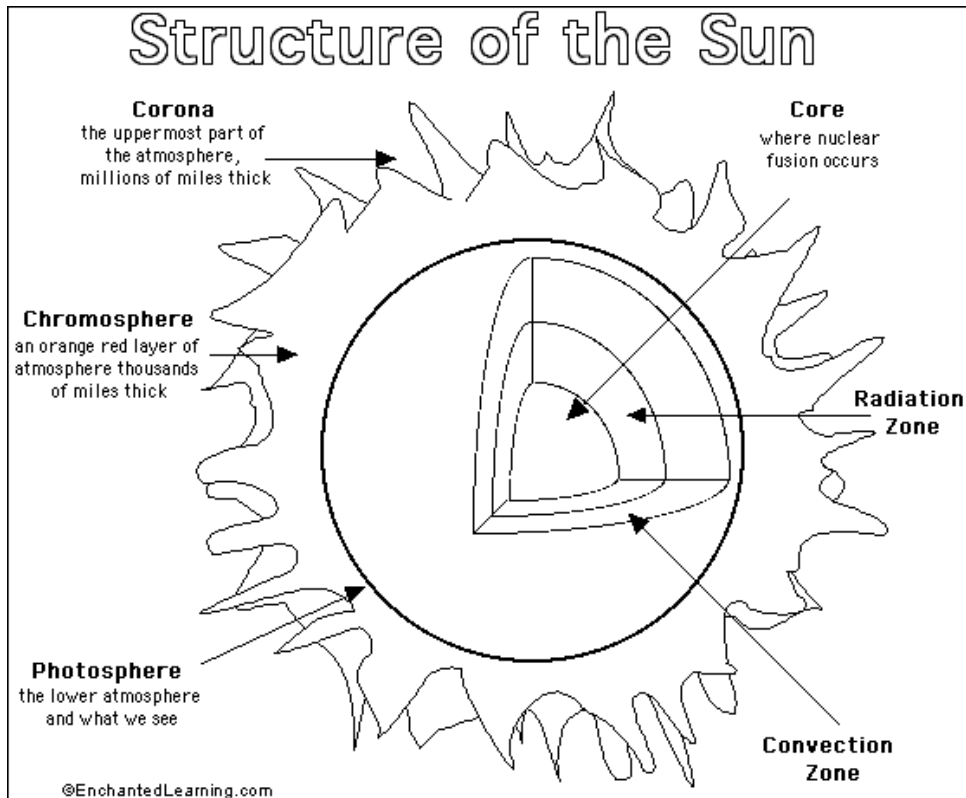
    NOTE: The descriptions do not need to be labelled. Only the bolded words need to be labelled. One point per label.

57. (3 points) A star is 10 parsecs away. What is the magnitude difference of this star?
    0
    In order to solve this problem, the distance modulus can be used. Or, you can use the definition of absolute magnitude in relation to apparent magnitude to determine this.

58. WASP-32 is a real star in the Milky Way. This star has a:

   ○ Radius: 1.11 $R_\odot$ ○ Luminosity: 1.5 $L_\odot$ ○ Absolute Magnitude: 4.3   ○ Apparent Magnitude: 11.26

   (a) (4 points) How far away is WASP-32?
   246.60 parsecs
   To do this problem, you will need the distance modulus, $d = 10^{\frac{m-M+5}{5}}$. Plug in the apparent and absolute magnitudes to get $d = 10^{\frac{11.26-4.3+5}{5}}$. Solve the equation in the exponent to get $d = 10^{2.392}$. Plug this into a calculator to get 246.60 parsecs.

   (b) (4 points) How bright does WASP-32 appear to earth? That is to say, what is its intensity, or apparent brightness (not apparent magnitude!) at Earth?
 $8.832 \times 10^{-13} \mathbf{W/m^2}$
   The first part of this question is to convert solar luminosities into watts and the distance you calculated in part (a) into meters. This can be done using the unit conversions at the front of the exam. Then, plug this into these values into the inverse squares law.

   (c) (4 points) What is the flux on the surface of WASP-32?
   $7.7998 \times 10^7 \mathbf{\ W/m^2}$
   The first step to this problem is to convert solar luminosities AND solar radii to Watts and Meters, respectively, using the unit conversions at the beginning of the exam, and knowledge of metric prefixes. Then, using your calculated radius, find the surface area of the sphere, $SA = 4\pi R^2$. Then, divide the total luminosity by the surface area of the star to get the flux on the surface of WASP-32.

   (d) (2 points) Which of the following spectra most likely represents that of this star? Correct Answer: A

   A.
   B.
   C.
   D.
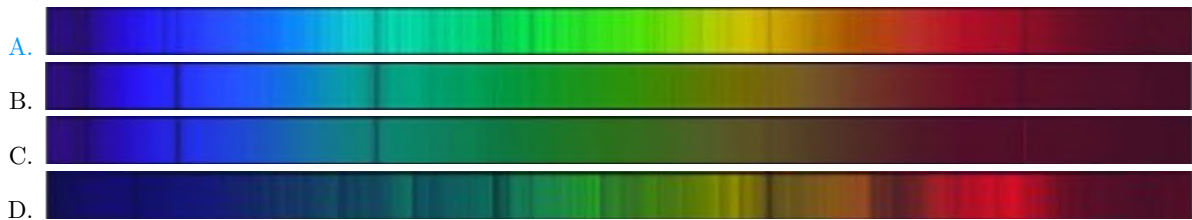
59. Rapeto is a real main-sequence star in the Milky Way. This star has a:

   ○ Luminosity: 2.20 $L_\odot$ ○ Spectral Class: F8   ○ Distance: 162 ly

   Assume the distance was calculated using parallax.

   (a) (2 points) What is the luminosity class of Rapeto?
   V

   (b) (4 points) If Rapeto emitted a blackbody spectrum, what wavelength would it peak in?
   460.32 nm
   Using the equation for Wien's law given at the beginning of the exam, and the knowledge that an F8 star is approximately 6300K, plugging the information in, we get 460.32nm

(c) (4 points) What is the absolute magnitude of Rapeto?

3.974

Using the definition of absolute magnitude ($M = 4.83 - 2.5\log(L_\odot)$) and the magnitude of the sun given at the start of the exam (4.83), you can plug in the luminosity in solar luminosities to get the absolute magnitude.

(d) (4 points) What is the apparent magnitude of Rapeto?

7.455

First, convert light-years to parsecs. Then plug the absolute magnitude you found in part (c) and the distance in parsecs into the distance modulus.

(e) (4 points) What is the parallax angle of Rapeto?

0.0201 arcseconds

First, convert distance in light-years to parsecs. Then, plug into the parallax equation given at the beginning of the exam.

(f) (3 points) Is the distance measurement to Rapeto reliable? Justify your answer.

Yes, the distance measurement is reliable because parallax angles can still be accurately measured for distances up to around 16000ly. Note: For full credit, an answer only needs to mention the angle measurement being accurate.

Part F: G A L A X I E S
10 questions, 20 points total.

60. (1 point) Which of the following is an example of a galaxy?

    A. Vega

    B. The Moon

    C. The Milky Way

    D. The Sun

61. (1 point) Which two features mainly differentiate an active galaxy from a normal galaxy?

    A. Size

    B. Distance

    C. Luminosity

    D. Spectrum

    E. Mass

    F. Star Type

62. I find a star cluster that has very red, and very old stars.

  (a) (1 point) What type of star cluster is this?

    A. Open Cluster

    B. Globular Cluster

    C. Red Cluster

    D. Spectral Cluster

  (b) (1 point) In what part of a spiral galaxy would I *most likely* find this star cluster?

    A. Halo

    B. Disk

    C. Bulge

    D. Nucleus

  (c) (1 point) Which of the following best describes the *most likely* orbital pattern of this star cluster in the galaxy?

    A. Random orbits in three dimensions.

    B. Ordered orbits about the center of the galaxy, along a plane with all the other stars.

    C. Disordered orbits in three dimensions, near the center of the galaxy.

    D. Just passing through the galaxy, no orbit about the center.

63. (1 point) If two spiral galaxies collide, the collision site will likely become

    A. starburst.

    B. red.

    C. a supermassive black hole.

    D. relatively cool.

64. (2 points) What is a galaxy?
A collection of stars and interstellar matter bound into one structure by gravity.

65. (2 points) What is the Hubble Classification of the Milky Way?
Either SBb or SBbc would work. Half points for Sb.

66. (2 points) What feature makes a galaxy considered "starburst"?
A high rate of star formation.

67. (8 points) For each of the following, match the galaxy picture to its Hubble class.

A	B	C	D
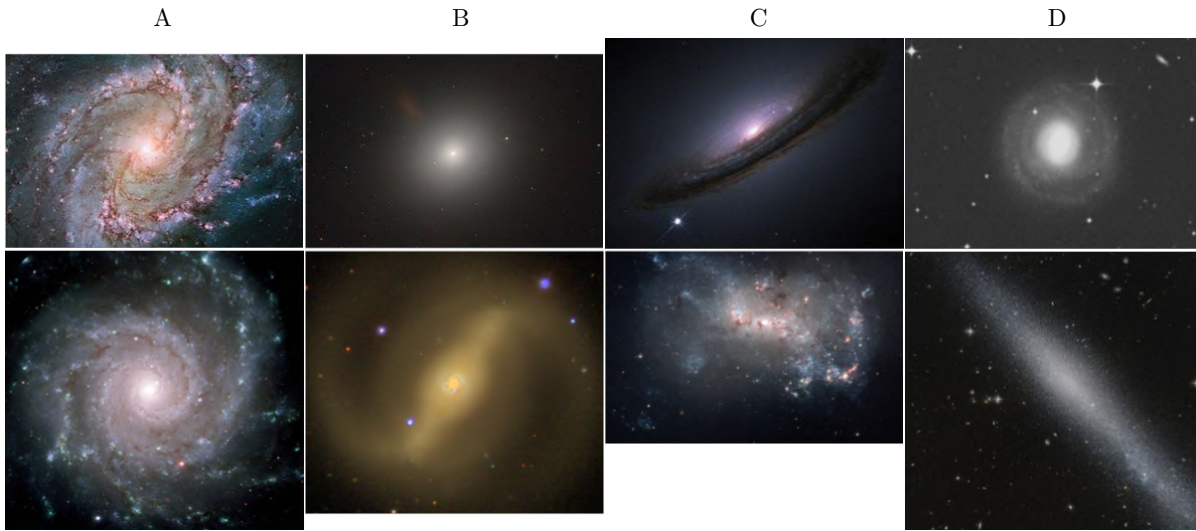
E	F	G	H

___C___ S0   ___E___ Sc   ___A___ SBc   ___H___ E7

___D___ Sa   ___F___ SBa   ___B___ E1   ___G___ Irr

Congratulations!

You have reached the end!