Team Name_____ Team #_____ Placement _____

ASTRONOMY
ATHENS INVITATIONAL
January 14, 2012

Directions: You may detach pages from this test booklet, but you **must** put them back in correct sequence and staple them together before handing in your test to the event supervisor. Failure to place the pages in order will be the first tie breaker. All exam materials **must** be returned or the team will be disqualified from the event. All multiple choice questions will be placed on the answer sheet provided. All problem sets and short answer responses are to be placed in the appropriate place as identified on the answer sheet. Show **ALL** work needed to solve any math problem or labels for a diagram.

Student signature_____

Student signature_____

You will have 50 minutes to answer as many questions as you can. Good Luck!

Tie-Breakers:

Questions 1- 50

1. How is the shape of stellar dust identified?
    A. Looking at the dust samples with the Hubble Telescope
    B. Using the reflective path of comets as they pass the nearest star
    C. Collecting the dust off meteorites and observing the shape of the dust particles using an electron microscope
    D. Using polarized light to infer the shape of the dust particle

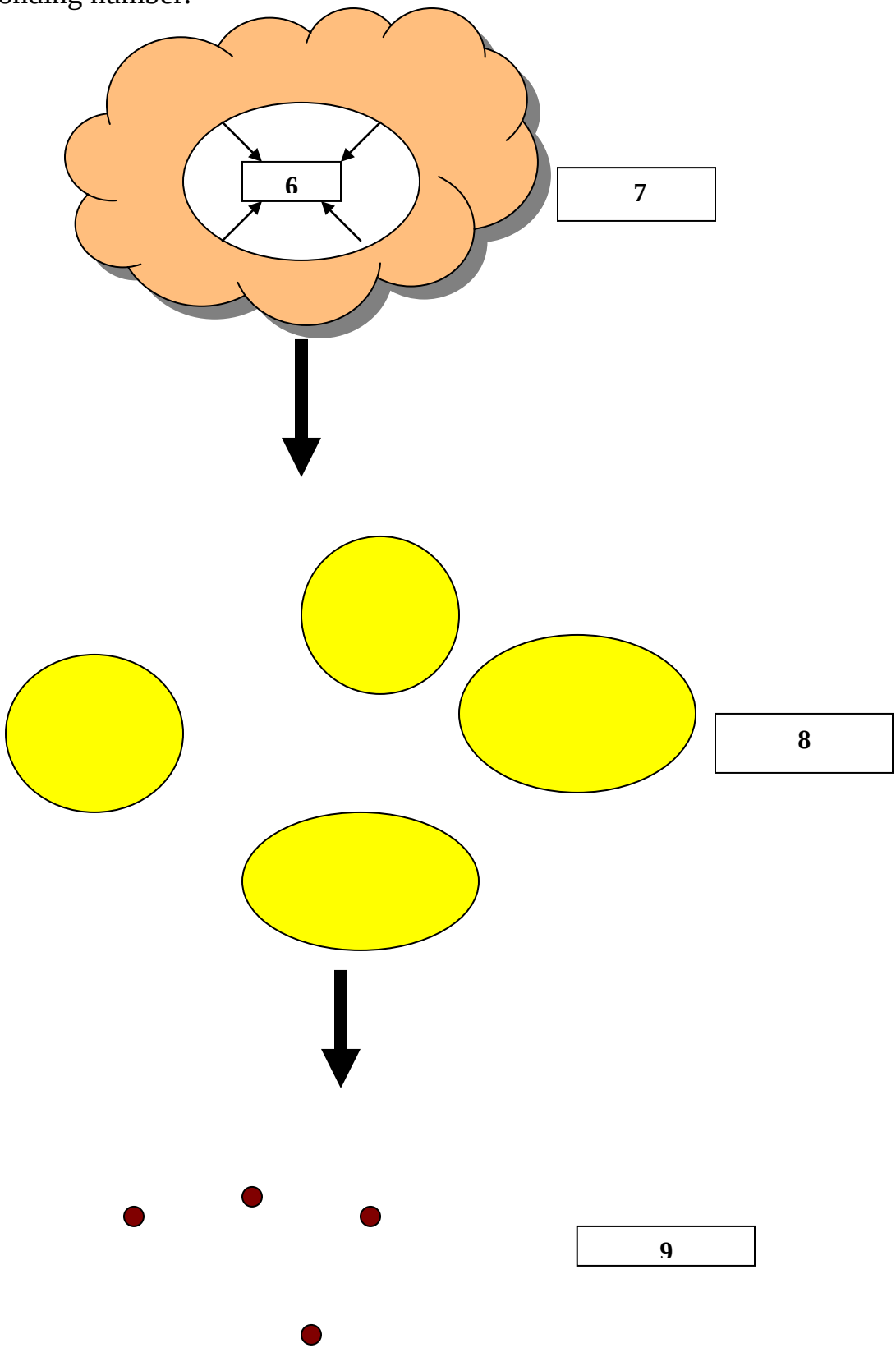
2. How are the gases from a star identified?
    A. Observing the electromagnetic spectrum of the star
    B. Observing the luminosity of the star
    C. Observing the color of the star
    D. Observing the positioning of the star in the binary system

3. Which is not identified as part of a Molecular Cloud?
    A. Having low densities
    B. Having high densities
    C. Dominated primarily by Hydrogen
    D. Very cold temperatures 10^6 K

4. Which of the following does not refer to interstellar medium?
    A. Is typically very cold, less than 100K
    B. Leads to extinction, reddening, and polarization of starlight
    C. Is a region where new stars are formed
    D. Is more massive than the stars

5. How are stars formed?
    A. The Big Bang formed all stars from the dust and debris spun off from the explosion
    B. When a Molecular Cloud contracts it will produce a star
    C. Nebulae condense and then expand to produce the heat needed for the formation of a star
    D. When a Black Body explodes the resultant energy is compressed by gravity to produce a star

For questions 6-9 use the diagram below which attempts to show a new star forming. Label the boxes with the event or structure formed or forming. Place the appropriate name on the answer sheet next to the corresponding number.



10. What name is given to the stars identified in number nine and can be found in the Orion Nebula?
    A. Neutron Stars
    B. T-Tauri stars
    C. Companion stars
    D. Mira variable stars

11. What is the average period of rotation for newly formed Protostars at or near the Main sequence?
    A. One Earth year
    B. One Earth month
    C. Fifteen Earth days
    D. One Earth day

12. What places a limit on the life of a star?
    A. Loss of mass, and therefore fuel, of the star into space by stellar winds
    B. Amount of fuel if contains
    C. Collisions between stars in a galaxy are sufficiently frequent that all stars will eventually be destroyed in this way
    D. Buildup of spin as it evolves and contracts means the star will eventually spin apart

13. What do we call a protostar that evolves to a point where it begins steady state hydrogen fusion in its core and first achieves hydrostatic equilibrium?
    A. First-born Main Sequence star
    B. Zero-age Main Sequence star
    C. T-Tauri star
    D. Proplyd

14. What is the minimum mass necessary in a protostar for it to begin nuclear reactions and become a Main Sequence star?
    A. 0.08 M_v
    B. 0.4 M_v
    C. 1.0 M_v
    D. 1.4 M_v

15. The evolution of a star is mainly controlled by its
    A. Chemical composition
    B. Surface temperature
    C. Initial mass
    D. Rate of fission

16. A Main Sequence star has a certain time of expectancy, *t*, due to the burning of its fuel in the core of the star. How is *t* related to the mass, M and luminosity, L of the star?
    A. $t \propto M/L$
    B. $t \propto ML$
    C. $t \propto L/M$
    D. $t \propto M^3$

17. How far away in parsecs is a star if it is determined to be 600 light years away from Earth?
    A. 600 pc
    B. 192 pc
    C. 184 pc
    D. 93 pc

*18. What is the distance from the Sun to Proxima Centuri first in ly, pc and AU?

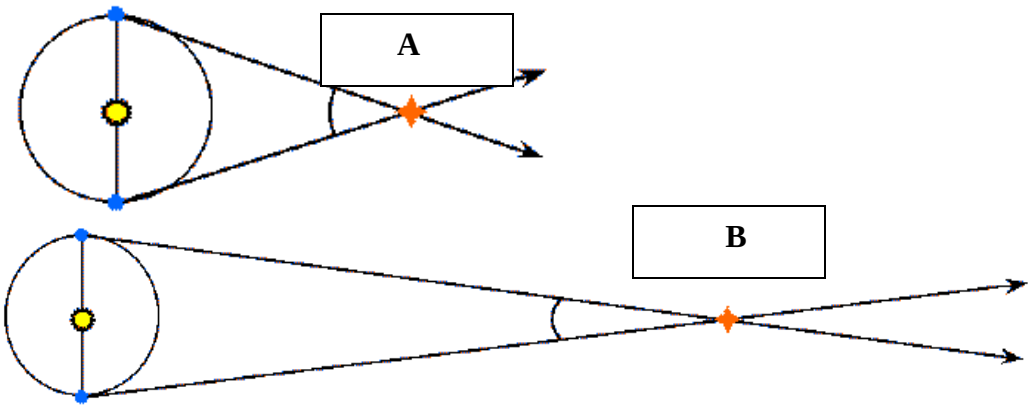
19. What mass loss is typical of Red Giants?
    A. 10^{-3} Sun_m/yr
    B. Red Giants mass remains constant
    C. 1.0 Sun_m/yr
    D. 10^{-7} Sun_m/yr

20. The temperature when thermonuclear reactions begin to convert Helium into Carbon or "Helium burning" is
    A. 15^6K
    B. 1.0^6K
    C. 1.0^9K
    D. 100^6K

21. A star has an arcsec of 0.454, what is its distance in parsecs?

A. 0.454 pc
B. 2.2 pc
C. 4.5 pc
D. 45 pc

22. What are the diagrams below attempting to illustrate?



A. The star angle is smaller at "A" than at "B"
B. The stars A and B are the same size
C. As the distance of the star increases the angle decreases
D. As the distance of the star decreases the angle decreases

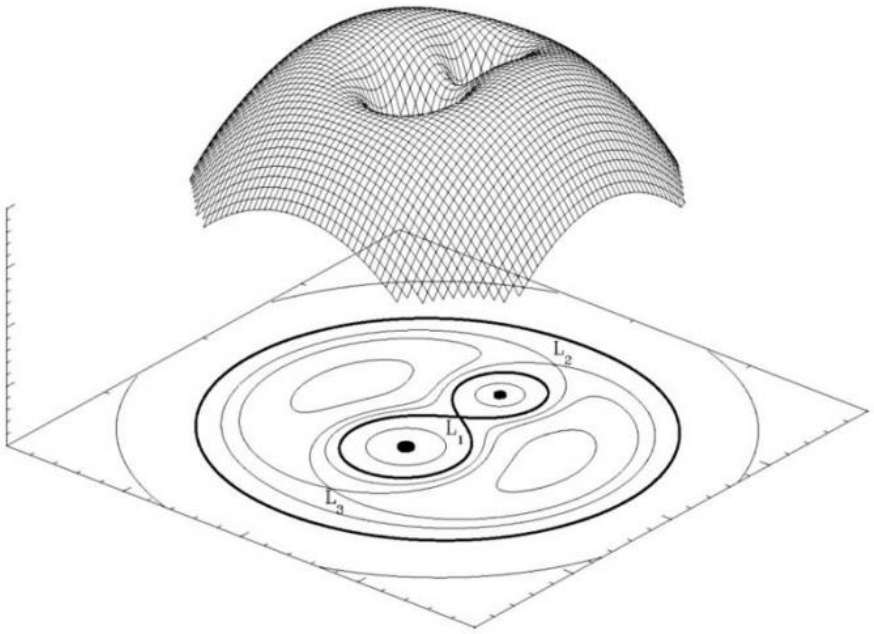
23. Where are most T-Tauri stars found on the H-R diagram?

A. Pre- Main sequence
B. Post- Main Sequence
C. Zero age- Main sequence
D. Main sequence turnoff

24. Which is not an attribute of the H-R diagram?

A. Shows stellar temperatures
B. Identifies the age of stars
C. Identifies electromagnetic radiation emitted from stars
D. Identifies the location of the different stars in the main sequence

25. What is the label L_1 in the diagram below referring to?



Place your answer next to the number 25 on the answer sheet.

26. What are the two types of variable stars?

27. What is the Spectral Class for Mira Variables?

A. F class
B. G Class
C. K Class
D. M Class

Questions 28-30 refer to the Image Data Bank 1: For each of the following questions observe the images and decide which Spectral Class each belongs.

28. Image 4 shows a typical star in the class which has prominent H and K lines.

29. Image 2 shows a typical star in the class in which there are all of the neutral metals and no hydrogen lines.

30. Image 1 shows a star class which represents 1 in 8 Main- sequence stars.

31. When is electron degeneracy pressure important in a star?
    A. During core hydrogen burning
    B. In a Mira variable that is burning helium in its core
    C. Just before the start of helium burning in the core
    D. In a Protostar evolving toward the Main-sequence

32. Why is Sirius different from most stars?
    A. It is burning helium by fusion in its core
    B. It is burning hydrogen by fusion in its core
    C. It is burning carbon by fusion in its core
    D. It is not burning anything

33. What is another name for cataclysmic variable stars?
    A. Supernovas
    B. Neutron Stars
    C. Type 1 Supernovas
    D. Type 1a Supernovas

34. What is the reason for the formation of a Brown Dwarf?
    A. The mass of the star is usually $< 0.08\ M_{sun}$
    B. The mass of the star is usually $< 1.5\ M_{sun}$
    C. The mass of the star is $> 8\ M_{sun}$
    D. The mass of the star is usually $> 50\ M_{sun}$

35. An astronomer plots the H-R diagram of a star cluster and finds it contains hot B type stars on the Main-sequence and cooler G and K type stars noticeable above the Main-sequence. This cluster is
    A. Impossible because there can't be cool stars above the Main-sequence when hot stars are on the Main-sequence
    B. Old because G and K stars are already evolving away from the Main-sequence
    C. Of an indeterminate age because the age of the cluster can't be determined from the information given
    D. Very young because the G and K stars are still evolving toward the Main-sequence

36. What happens to a star's when it's evolutionary track on the H-R diagram carries it into the instability strip?
    A. It collapses and forms a black hole
    B. It pulsates randomly in brightness
    C. It pulsates regularly in brightness
    D. It explodes

37. What do we call a comparison of the absolute brightness with a star's measured apparent brightness to identify the distance to that star?
    A. The B-V Index
    B. Stellar parallax
    C. DS9 Analysis
    D. Spectroscopic parallax

38. Identify the type of Nebulae as found in Data Image Bank 2.

39. What does the abbreviation "SNR" translate into?

40. The Glowing from excitation caused by nearby stars produces what type of Nebula?
    A. Spectral Nebulae
    B. Emission Nebulae
    C. Reflection Nebulae
    D. Absorption Nebulae

For questions 41-48 refer to the following scenario, "A star 20 pc away has 170 $L_{\odot}$ and has a surface temperature of 4.0×10^3 K. Research has shown it to have a redshift of 0.0002028. Additionally, the star showed 2.70 arcsec of proper motion when studied from July 1994 to July 2004."

41. What is the star's true space motion in km/s?

42. What is the star's absolute magnitude?

43. What is the star's parallax in arcseconds?

44. What is the star's spectral class?

45. What is the star's radius in solar radii?

46. What is the wavelength at which the star radiates the most energy in angstroms?

47. What is the star's transverse velocity in km/s?

48. What is the star's recessional velocity in km/s?

49. RR Lyrae variables are likely to be found in
    A. very young clusters, where high-mass stars are undergoing core hydrogen burning
    B. giant molecule clouds, where protostars are forming from dust and gas clouds.
    C. young-to-intermediate age clusters, where high mass stars are undergoing central helium burning
    D. Globular clusters, where low-mass stars are undergoing core helium burning

50. At what process are most stars found in the Main sequence?

For Questions 51 to 70 refer to the diagram, figure, or picture to answer the questions.

51. What do the five diagrams Seen Data Image Bank 2 tell us about these stars?

52. What is implied by the stars in the diagram found in Data Image Bank 3?

53. Look at the diagram on Data Image Bank 3 and identify the cluster and relative age of the stars in the cluster.

For numbers 54 to 58, fill-in the blanks found in the information about Cataclysmic variables below. There are three words to be filled in for number 54

Cataclysmic variables provide a unique laboratory for the study of two fundamental astrophysical processes: accretion and _____54,_____. Accretion is the process by which ____55____ is able to overcome the ____56_____ momentum barrier which would normally prevent material from spiraling inwards to form compact objects like the Sun. Cataclysmic variable stars have been central to many developments in the theory of _____57_____discs. This is because the discs in these systems are nearby (and hence bright), they evolve on very short timescales (___58___ to ___58____).

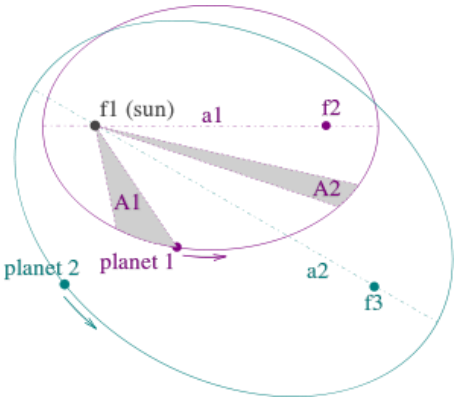
59. What is the diagram on Data Image Bank 4 showing as it relates to Planetary nebula?

60. What is the diagram on Data Image Bank 4 showing to you the observer?

61. Write the formula for Absolute Magnitude.

62. A star has apparent magnitudes U = -0.24, B = 0.7, and (63.) V = 0.9 in the UV, blue, and photovisual regions, respectively. What are the corresponding color indices?

64. Looking at the diagram below, what Laws are being represented?



65. In the diagram above what does f1 and f3 represent?

66. Look for the arc in the picture on Data Image Bank 5, what does this tell us about this SNR?

67. What is the name for this SNR?

68. What is the name of this Nebula and what is in its' center? Look on Data Image Bank 5.

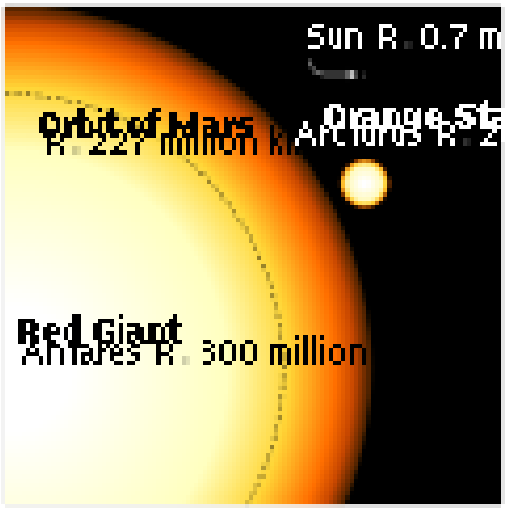
69. What type of telescope must be used to observe the nebula in question 68?

70. The image found on Data Image Bank 6 is an X-ray binary star system composed of two white dwarf stars orbiting each other about every 321.5 seconds. What is the name of this system?

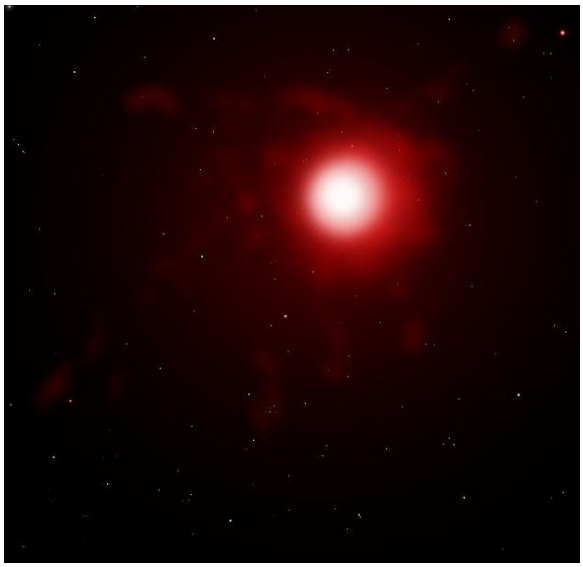
71. Compared to star "A" (51,500 pc from Earth), the star "B" (3.6 million pc from Earth) had a maximum brightness only 9.1×10^{-4} as great. Using the distance from Earth to each star, determine the ratio of the maximum luminosity of star "B" to that of star "A."

Image Data Bank 1:

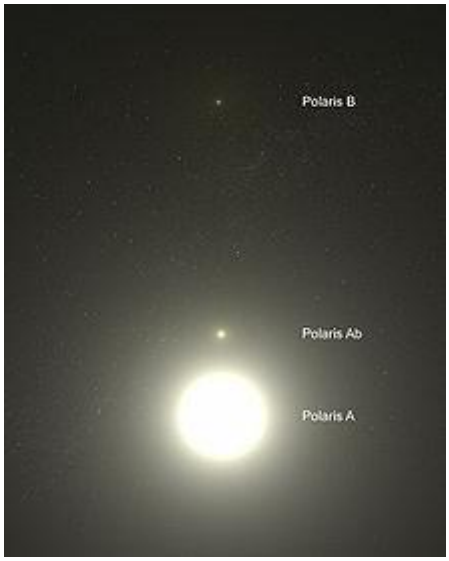
1



2



3



4

Data Image Bank 2

Image for Question 38

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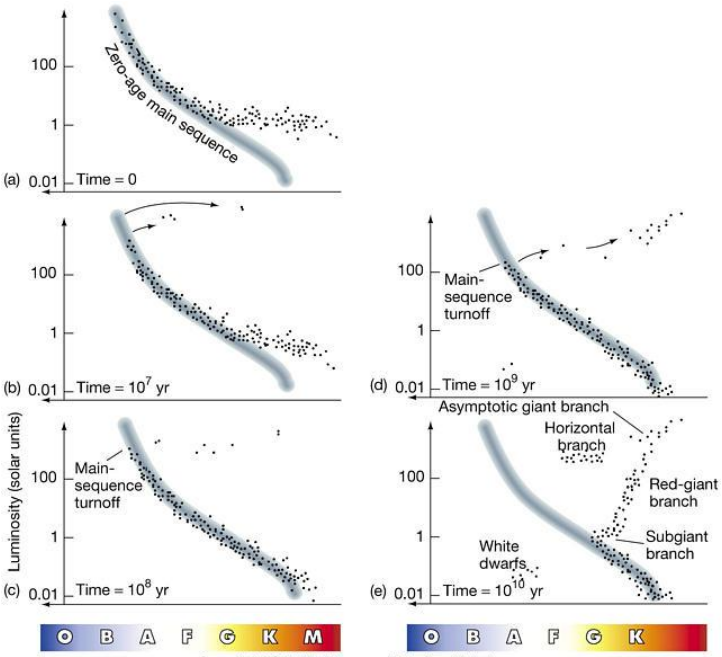
Image for Question 51



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Data Image Bank 3

Image for Question 52

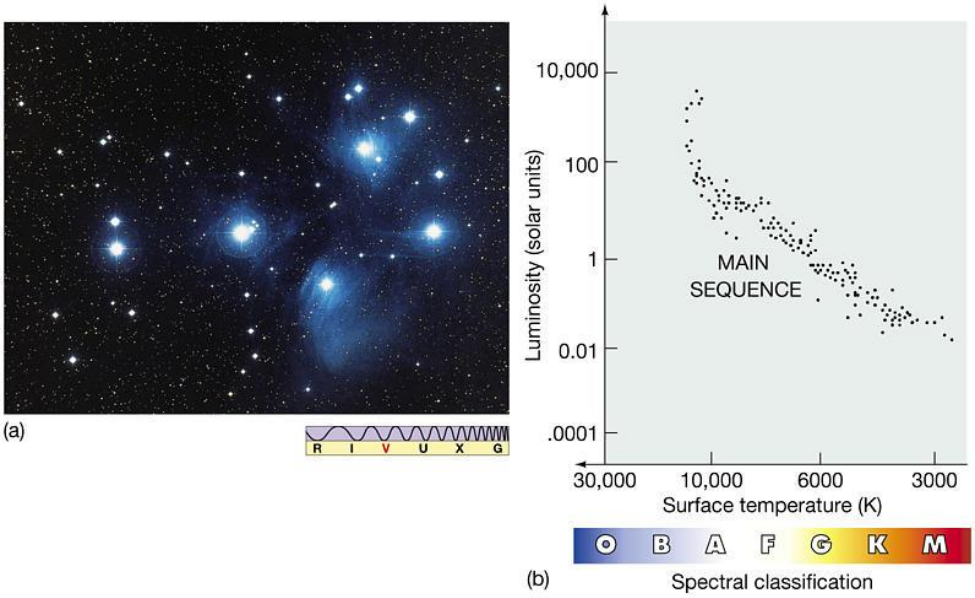

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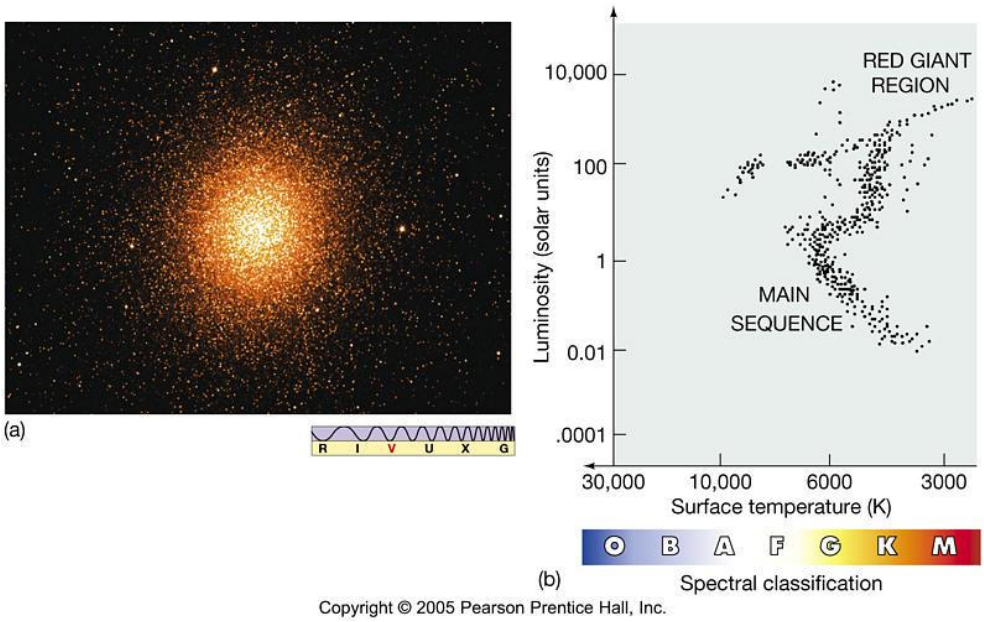
Image for Question 53



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Data Image Bank 4

Image for Question 59

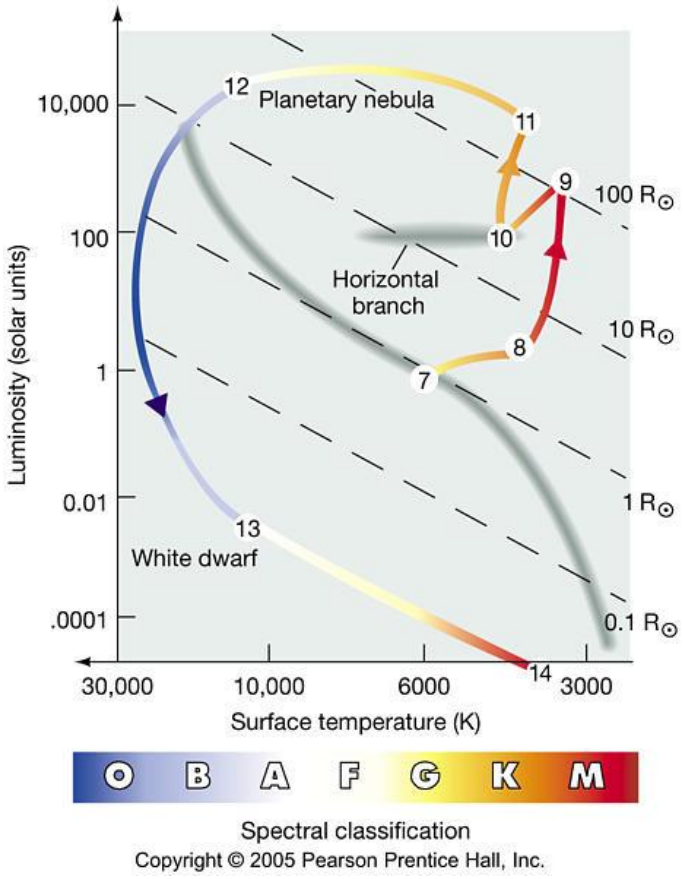
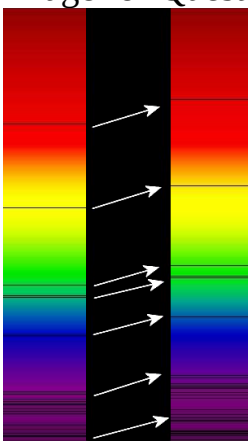


Image for Question 60



Data Image Bank 5

Image for Questions 66 and 67

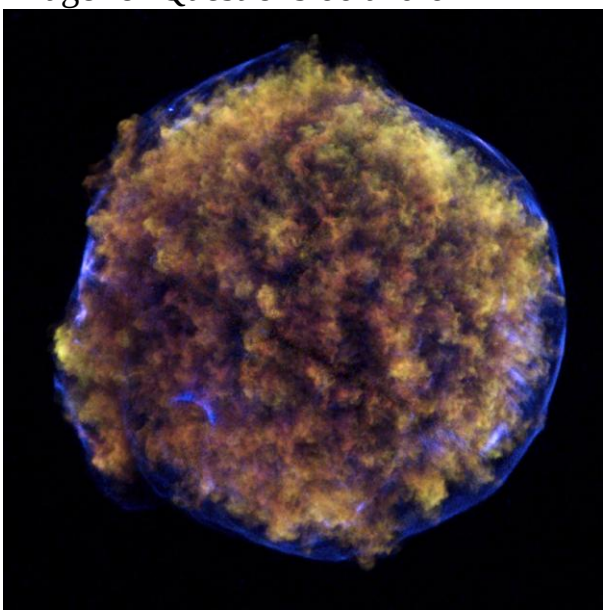
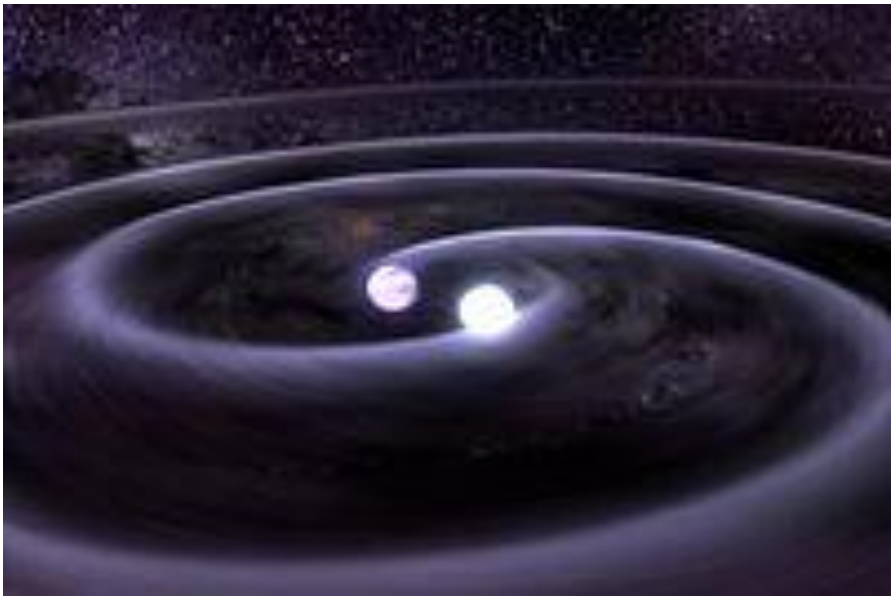


Image for Question 68

Image Bank 6

Image for Question 70



Astronomy Answer Sheet
Athens Invitational 2012

Team Name_____
Team # _____
Placement _____

1. _____
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18. _____ ly, _____pc, _____AU
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Astronomy Answer Sheet
Athens Invitational
2012

1. **D**
2. **A**
3. **A**
4. **D**
5. **B**
6. **Self- gravity**
7. **Molecular Cloud or Dark Nebula**
8. **Cloud fragments**
9. **Protostars**
10. **B**
11. **C**
12. **B**
13. **B**
14. **A**
15. **C**
16. **A**
17. **C**
18. *** This is a 3 point question and partial credit is awarded. 4.24 ly, 1.3 pc, and $2.68E^5$ AU**
19. **D**
20. **D**
21. **B**
22. **C**
23. **A**
24. **D**
25. **Lagrangian point**
26. **Intrinsic and Extrinsic Variable stars**
27. **M Class**
28. **G Class**
29. **M Class**
30. **K Class**
31. **C**
32. **C**
33. **D**
34. **A**
35. **D**
36. **C**
37. **D**
38. **Absorption nebulae**
39. **Super Nova Remnant**
40. **B**
41. **66.0 km/s**
42. **-.75**
43. **.05 arcsec**
44. **K**
45. **27.1**

46. **7250 angstroms**
47. **25.6 km/s**
48. **60.8 km/s**
49. **D**
50. **Carbon Burning Process**
51. **Shows the "Turn-off Points" and age of the stars**
52. **They are Galactic clusters or young stars**
53. **Globular Cluster of very old stars**
54. **binary star evolution**
55. **matter**
56. **angular**
57. **accretion**
58. **hours to weeks**
59. **The Solar mass star ejects the planetary nebula, and eventually collapses to a White Dwarf**
60. **There is a Red Shift when compared to the left side of the diagram**
61. $M = m - 5((\log_{10} D_L) - 1)$
62. **B - V = 0.7 - 0.9 = - 0.2**
63. **U - B = -0.24 -0.7 = - 0.94**
64. **Kepler's Three Laws with two Planetary orbits, Eccentricity and equal shade areas**
65. **Focal length**
66. **The SNR was formed from the addition of accreted materials as seen in the accretion arc form a bigger companion star**
67. **Tycho's SNR**
68. **Rosetta Nebula has very hoot and very young stars in its' center**
69. **X-Ray telescope**
70. **RX J0806.3+1527 or HM Cancri**
71. **$L_1/L_2 = (d_1/d_2)^2 (b_1/b_2)$,**

    $b_1/b_2 = 9.1 \times 10^{-4}$
    $d_1 = 3.6 \times 10^6$ pc for Star "A,"
    $d_2 = 5.1 \times 10^4$ pc for Star "B"

    $L_1/L_2 = (3.6 \times 10^6/5.1 \times 10^4)^2 (9.1 \times 10^{-4}) = 4.5$