Name _____ Date _____ Moravian Exam _____

The Evolution of Stars—Study Guide

INSTRUCTIONS: Make sure that your first and your last name and date appear at all applicable locations, yes, even the first page. This examination is in the form of multiple choice and a few fill-in-the blank questions/statements. After reading the question or instructions carefully, select your answer(s) and mark it (or them) plainly on the answer sheet provided with this test. The answer sheet can be found at the end of the exam. You may detach it. Only answer the odd or even questions depending upon whether your exam number is odd or even. **Take a moment to circle the questions which are your questions throughout the exam.** You may work alone or with **ONE PARTNER** who is taking the other portion of the exam to help each other attain a higher grade. **There will be no communications between teams.** All correct answers must be provided to receive full credit; however, partial credit will be given unless stated otherwise. This exam has a total value of 20 points. **MUCH SUCCES!**

CANVAS INSTRUCTIONS: This Quest is in the form of multiple-choice questions and a few fill-in-the blanks. After reading the question carefully, select your answer or answers. **If the question calls for multiple answers, two or more, you must provide all answers and all answers must be correct.** Canvas does not allow for partial credit. Because of this, I will give you two attempts to take the test. Consider this open book. All answers can be found in the lecture material created in class, the assigned reading material, and the PowerPoint presentations, but if you feel the need to consult online sources, books, or magazines, please feel free to do so. This Quest has a total value of 20 points. **MUCH SUCCESS!!!**

EVOLUTION OF STARS

INSTRUCTIONS: The first 10 questions detail the characteristics of main sequence stars. Your only two answers are **INCREASES** or **DECREASES, "I" or "D"**. Consider the characteristics of stars starting at O_4 and proceeding to M_8 and how these characteristics would change as movement occurred from the O class to the M class. A few other questions which follow also will also use the words increases and decreases as answers. They deal with volume, temperature, and rotational speed.

1. O_4 to M_8: The surface temperature of the star…

2. O_4 to M_8: The mass of the star…

3. O_4 to M_8: The time for contraction to zero age main sequence…

4. O_4 to M_8: The luminosity of the star…

5. O_4 to M_8: The absolute magnitude of the star…

6. O_4 to M_8: The life expectancy of the star…

7. O_4 to M_8: The physical size of the star…

8. As the volume of a gas cloud decreases the density of that gas cloud will…

9. A gas cloud starts off with a certain temperature and with a slight rotational motion. If there is sufficient mass and the cloud begins to contract, let's say to form a star, the temperature of that cloud will begin to… Think of the Fahrenheit 451 experiment (the tube and plunger).
Key Concepts: The characteristics of main sequence stars on the H-R diagram are tested here.

10. A gas cloud starts off with a certain temperature and a slight rotational motion. If there is a sufficient mass and the cloud begins to contract, the rotational speed of the cloud will begin to… Think of an ice skater performing a pirouette.
Key Concept: Early evolution of stars… What happens to the nebular cloud as it contracts to form a star? Angular momentum…

End of increase/decrease "I" "D" questions…

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11. If two identical sodium vapor streetlights are viewed simultaneously from a distance of one city block (1/8 mile) and two miles respectively, the streetlamp at a distance of one block (1/8 mile) will appear how many times brighter than the lamp two miles distant?
Key Concept: Inverse square law…

12. The magnitude scale quantified in the 19th century was first used by the Greeks two thousand years ago. Choose the **CORRECT** statement.
Key Concept: Understand how astronomers quantify the brightnesses of the stars.

13. The star with the brightest absolute magnitude in the list is
Key Concept: Understand the nonintuitive aspect of stellar brightnesses with respect to positive and negative magnitude as well as the definition of absolute magnitude.

14. The star with the brightest apparent magnitude as viewed from the Earth in the following list is
Key Concept: Understand the definition of apparent magnitude and magnitude system in general including its major misconceptions.

15. Until the 19th century (early 1800s), it was impossible to compare the true brightnesses of the stars with each other because
Key Concept: Understand how being able to find the parallax of nearby stars played a key role in learning about the true nature of the stars.

16. Which list gives the correct ordering of the various parts of the electromagnetic spectrum from **highest frequency to lowest frequency**? Not all of the energies of the electromagnetic spectrum are represented in each list.
Key Concept: Understand how the number of wave crests passing a position each second (frequency) plays a role in defining their energies. State the different parts of the electromagnetic spectrum in their correct order according to frequency.

17. Which list gives the correct ordering of the various parts of the electromagnetic spectrum from **most energetic to least energetic**? Not all of the energies of the electromagnetic spectrum are represented in each list.
Key Concept: Know the correct ordering of the various parts of the electromagnetic spectrum.

18. Which list gives the correct ordering of the various parts of the electromagnetic spectrum from **longest wavelength to shortest wavelength**? Not all of the energies of the electromagnetic spectrum are represented in each list.
Key Concept: Be able to state the different parts of the electromagnetic spectrum in order of wavelengths.

19. Which one of the following forms of energy is not part of the electromagnetic spectrum?
Key Concept: Understand the different terminologies for the wave and particle descriptions of electromagnetic radiation.

20. The various gasses that were fluoresced in the lesson that discussed emission spectra
Key Concept: Why are laboratory experiment conducted with fluorescing gasses to understand absorption spectra? What is the relationship between emission and absorption spectra of the same element or compound?

21. There are two basic descriptions of light. Which word relating to one of these descriptions does not belong in the following list?
Key Concept: Understand that the light (electromagnetic radiation) passing an opaque object and light striking a light sensitive surface must be described differently.

22. The speed of the various energies of the electromagnetic spectrum is always
Key Concept: What does all electromagnetic radiation have in common?

23. When the speed of light slows because the electromagnetic energy has passed from a less dense medium to a denser medium, the light is said to be bent or
Key Concept: Descriptively understand Snell's Law.

24. **Pick two correct answers.** Black body radiation curves allow astronomers to:
Key Concept: Understand the black body radiation curves of stars of different temperatures, one of the more important slides in Becker's PowerPoint program.

25. The following statements are true. The sun's surface temperature is 5778K. If that number is plugged into Wein's Law, the wavelength of light which the sun most frequently emits is at 5016 Angstroms or 501.6 nanometers. This wavelength converted into a color is basically green. Why is the sun called or thought of as a yellow star?
Key Concept: Understand Wein's Law, the characteristics of black body radiation curves for stars of different temperatures, and how colors blend in an additive sense.

26. Star A is hotter than star B. Star A will
Key Concept: Understand the characteristics of black body radiation curves for stars of different temperatures and how they would be represented graphically.

27. The sun's blackbody radiation curve peaks in the green, right in the middle of the visible spectrum of colors. Why is the sun not a green star?
Key Concept: Understand the what happens when all of the visible color of the spectrum are added together and apply this to a blackbody radiation curve that peaks in the green, like our sun.

28. According to the Bohr Theory of the atom, when a specific quanta or energy level is absorbed by an electron,
Key Concept: Understand how Niels Bohr explained fluorescence and absorption. Remember the glow tubes that we fluoresced in the Emission Spectrum Lab.

29. If an electron in a hydrogen atom were to jump from the n = 3 level to the n = 2 level,
Key Concept: Understand how the energy of an electron changes when it jumps from a higher orbital to a lower orbital. The n=2 level is very significant for the hydrogen atom because some of the downward transitions produce visible light.

30. Standing near a lightbulb with a tungsten filament shining at a blackbody radiation temperature of 2700 K.
Key Concept: Understand Kirchhoff three laws of spectroscopy, and the most frequently emitted energy from blackbody radiation curves of different temperature.

31. A star with a blackbody radiation curve of 2700 K.
Key Concept: Understand Kirchhoff three laws of spectroscopy, and the most frequently emitted energy from blackbody radiation curves of different temperature.

32. The basis behind absorption spectroscopy or the formation of the absorption spectrum is
Key Concept: Understand Kirchhoff three laws of spectroscopy, but particularly the third law in this instance.

33. By attempting to analyze the absorption spectrum of the sun or any other star, astronomers can learn what important facts about the object?
Key Concept: Absorption lines found in a spectrum qualifies/quantifies what key facts about the star being observed?

34. The spectral classification of a star that falls along the main sequence of the Hertzsprung-Russell diagram, **FAILS** to directly tell astronomers which one of the following characteristics about that star.
Key Concept: Understand what the "X" and "Y" axes of an H-R diagram represent. The position of a star on the main sequence tells astronomers what?

35. The spectral classification of main sequence stars, O, B, A, F, G, K, M is best described as a…
Key Concept: Understand the spectral characteristics of O, B, A, F, G, K, and M stars. The spectral classification of stars also represents the X-axis of the Hertzsprung-Russell diagram.

36. According to the spectral classification pairs given below, which two stars represent the greatest differences in temperature?
Key Concept: Understand the temperature ranges of each of the spectral types (O, B, A, F, G, K, and M) is greater for hotter stars and less for cooler stars.

37. The relative strength of the dark absorption lines of stellar spectra are
Key Concept: The strengths of absorption lines are a function of what property of a star?

38. To classify a star in the OBAFGKM system with the greatest accuracy
Key Concept: Understand that the spectral line strengths of different elements varies with temperature and that by comparing line strengths of standard elements to one another the temperature of a star may be obtained.

39. When a spectrogram of the sun is examined, it is found that the darkest absorption lines darkest absorption lines which are present result from singly ionized calcium, neutral iron, and neutral magnesium. Hydrogen is prominent, but not dominant. What does this tell you about the sun?
Key Concept: The strengths of absorption lines are a function of what property of a star?

40. The existence of compounds in the spectrum of a star would indicate that this star is
Key Concept: Molecular bonds are weaker than the bonds between the electrons and nucleus of an atom, so when molecules form in the atmospheres of star, this is a key indicator of what aspect of the star?

41. The most massive stars known are approximately how many times more massive than the sun?
Key Concept: Understand that there are limits to the mass of stars, both high and low, just like there are limits to the human family.

42. A star with 30 times the mass of the sun would
Key Concept: How does the mass of a star affects its lifespan.

43. The brightest star listed below would be at a magnitude of
Key Concept: Understand key concepts magnitude system for measuring the brightnesses of stars.

44. The brightest star listed below would be at an absolute magnitude of
Key Concept: Understand the differences between absolute and apparent magnitudes.

45. When the three bright stars of the Great Summer Triangle were compared in the laboratory exercise completed in class, it was discovered that
Key Concept: In order to make comparisons of objects that we believe have similar characteristics, we must observe them from the same distance.

46. If star A is five magnitudes brighter than star B. The brightness of star A is how many times greater than star B? A difference of one magnitude equals an intensity difference of 2.51.
Key Concept: Understand key concepts of the nonintuitive magnitude system for measuring the brightnesses of stars.

47. The absolute magnitude of a star is
Key Concept: Know the definition for absolute magnitude.

48. Pick the best answer. The absolute magnitude of a star directly allows astronomers to easily understand that star's
Key Concept: Know the definition for absolute magnitude and understanding why it is important to know.

49. One parsec is a unit of distance
Key Concept: Know the definition of a parsec.

50. Consider two stars. The temperature of one of the stars is twice as great as the temperature of the second star. Which statement is true?
Key Concept: Understand what black body radiation curves tell us about the property of stars.

51. The most numerous grouping of stars on the main sequence in the Milky Way galaxy is found to be of spectral classification
Key Concept: Which main sequence stars are the most abundant?

52. The spectral classifications of the stars which are lighting up the bluish arms of spiral galaxies like the Milky Way are
Key Concept: Understand how the luminosities and spectral types of stars could affect the color of a galaxy. Consider the image of the Cartwheel Galaxy shown to you in class and consider why the "wheel" looks bluish.

53. Find the **INCORRECT** statement. The Hertzsprung-Russell diagram charts the
Key Concept: What do the "X" and "Y" axes of the H-R diagram represent?

54. The Hertzsprung-Russell diagram allows astronomers to understand
Key Concept: Understand the meaning of the "X" and "Y" axes of the H-R diagram and their interrelationship to each other.

55. The Hertzsprung-Russell diagram
Key Concept: Understand the meaning of the "X" and "Y" axes of the H-R diagram and their interrelationship to each other.

56. In astronomy, when "burning" is used in relation to stars, it really means
Key Concept: Energy production in stars is referred to by astronomy as "burning." What does that really mean.

57. Stars that are "burning" hydrogen into helium as their main energy source will be found exclusively
Key Concept: Understand the luminosity/spectral classifications of star, how stars create their energy in their cores, and why stars are found in a specific location on the H-R diagram.

58. The position of a main sequence star on an H-R diagram is a result of that star's
Key Concept: The luminosity/spectral classification of a star on the main sequence is directly related to what specific property of that star?

59. Stars which are very cool, but extremely luminous are called _____ (Place your answer on the answer sheet).
Key Concept: Understand the concepts about the different basic luminosity classifications of stars on the H-R diagram and what they divulge about a star's physical characteristics.

60. Stars which are very faint, but have high surface temperatures are called _____ (Place your answer on the answer sheet).
Key Concept: Understand basic concepts about luminosity classifications of stars on the H-R diagram and what they divulge about a star's physical characteristics.

61. Stars which are very luminous, and have high surface temperatures are called _____ (Place your answer on the answer sheet).
Key Concept: Understand basic concepts about luminosity classifications of the H-R diagram.

62. State the name of the brightest (apparent magnitude) main sequence star in the sky _____ (Place your answer on the answer sheet).
Key Concept: Understand the definition for apparent magnitude.

Picture of an H-R Diagram goes here!

INSTRUCTIONS: Make use of this H-R diagram from question 60 through question 72. The same star may be used multiple times.
Key Concept: Understand how Hertzsprung-Russell diagram can provide information about the evolution of the stars.

63. Which one of the named stars listed below has the highest absolute luminosity?

64. Which one of the named white dwarf stars might be assumed to be the oldest?

65. Which of the named stars listed below are undergoing core hydrogen burning?

66. Name the stars which are burning helium or heavier elements as fuels?

67. Which one of the named stars listed is closest to death?

68. What condition causes blue stars in the upper left of the H-R diagram to be extremely luminous?

69. Which one of the named stars below has the lowest luminosity?

70. The white dwarf star possessing the lowest luminosity is dimmest because of its surface temperature or its size?

71. Which one of the named stars has the highest surface temperature?

72. What will be the ultimate fate of the three main sequence stars named in the H-R diagram?

73. Was Procyon B ever a main sequence star?

74. Predict the next life stage into which the star Vega will evolve?

75. At 19 solar masses, what will be the ultimate fate of Deneb as a dead star?

76. A shock front
Key Concept: What is a shock front? Understand the key properties of a shock front.

77. Which of the following events could realistically **trigger** the formation of a star cluster? You are required to state **two** of them.
Key Concept: Understand the manner in which a shock front is created and how this influences the formation of star clusters like the Pleiades or the Orion nebula.

78. Pick the **INCORRECT** answer. When a cluster of stars is formed through some shock front mechanism,
Key Concept: Understand the concept of a shock front and the sequence of stellar evolution in star clusters like the Pleiades or the Orion nebula.

79. Which statement about the Orion nebula is **FALSE**?
Key Concept: What is really happening inside the Orion nebula?

80. During the very early phases of a star's formation, its energy comes from
Key Concept: Understand the perfect gas laws as a huge cloud of gas and dust contracts.

81. When a new star is forming, what is the event that halts the process of contraction?
Key Concept: Understand the different key steps in the formation of a star like the sun.

82. Thermonuclear fusion is just another way of saying
Key Concept: Consider what is happening inside the core of a star at the most fundamental level so that a star can shine.

83. Lower mass stars, like our sun, contract onto the main sequence and then change ever so slowly during their lives on the man sequence. At the position of a zero-age main sequence star like our sun, its luminary (star) is
Key Concept: Since the main sequence has thickness, qualitatively, where did the sun start its hydrogen fusion on the main sequence?

84. Lower mass stars, like our sun, contract onto the main sequence and then change ever so slowly during their lives. By the time that the star is ready to leave the main sequence, it has become
Key Concept: Since the main sequence has thickness, qualitatively, where will the sun end its hydrogen fusion on the main sequence?

85. Size-wise, a star that has become slightly cooler but more luminous changes in what way with respect to size.
Key Concept: Since the main sequence has thickness, quantitatively this should affect a star's size during its lifetime on the main sequence—or maybe not!

86. The event that marks the end of a star's existence on the main sequence occurs when the star
Key Concept: Understand the different steps in the evolution of a star like our sun.

87. When a star evolves from the main sequence into its red giant phase,
Key Concept: Consider what changes are occurring in the core of a star when it evolves into a red giant

88. When a low mass star like our sun ascends to the red giant region of the H-R diagram, an event known as the helium flash may occur. The helium core is degenerate. It does not obey the perfect gas laws (volume of gas expands when heated, contracts when cooled). When helium burning begins, it rips through the star's core, but not much happens. Eventually, so much energy is released from the helium fusion that the core material is rapidly expanded out of its state of degeneracy. This slows the helium burning in the core of the star and causes the star to become
Key Concept: Where will a star migrate on the H-R diagram after the helium flash? Think about the changes in luminosity and temperature of the star when this occurs.

89. When a massive star ascends into the supergiant branch, the far upper right area of the H-R diagram, this means that
Key Concept: Understand how massive stars keep spontaneously inventing new thermonuclear processes to sustain themselves against gravitational collapse. Think of the core of a massive star looking like an onion.

90. Examining the H-R diagram shows that there are few stars in the giant and supergiant categories. What causes this situation to occur?
Key Concept: Understand the percentage of time that stars remain in certain locations on the H-R diagram, i.e., undergoing certain thermonuclear processes within their cores.

91. Inspecting the H-R diagram shows that there are few stars in the white dwarf category. Why is this true?
Key Concept: Understand how distance affects the visibility of low luminosity stars.

92. After leaving the main sequence, the sun will first evolve into a
Key Concept: Understand the evolution of relatively low mass stars like our sun. A good example of the sun's future fate might be Aldebaran in the constellation of Taurus the Bull.

93. Our sun will eventually have an inert helium core surrounded by a thinning, less stable shell of hydrogen gas which is undergoing thermonuclear fusion. This will cause the sun
Key Concept: Understand the changes in thermonuclear fusion in relatively low mass stars like our sun as they evolve off the main sequence when hydrogen in their cores is depleted.

94. The end stage in the evolution of a star similar to our sun will cause it to become a
Key Concept: Understand the final evolutionary sequence of a solar mass star.

95. Find one **astronomically** **INCORRECT** statement about white dwarf stars.
Key Concept: Interpret the meaning of the location of white dwarfs on an H-R diagram.

96. Astronomers currently believe that elements more massive than iron are created in
Key Concept: Understand the last step in the evolution of very massive stars.

97. Six billion years ago, the heavier atoms found in your body were most probably
Key Concept: Where are the heavier elements formed and how do they seed the universe? Is our sun a first generation star?

98. Whether a star sits at the upper left-hand corner of the main sequence or the lower right hand corner of the main sequence or as a white dwarf or as a super red giant depends upon that stars.
Key Concept: One concept governs a star's location on the Hertzsprung-Russell diagram?

99. Whether a star becomes a white dwarf, a neutron star, or a black hole is considered to depend upon its remaining
Key Concept: One concept governs a star's location on the Hertzsprung-Russell diagram?

100. In order for a star or an object to evolve into a black hole or a black hole in a binary system…
Key Concept: Understand that what mass remains after the death of a star will affect its end evolutionary outcome.

101. An astronomer plots the appropriate characteristics of many stars in a cluster to create an H-R diagram. She/he finds that the most luminous O and B stars have reached the main sequence, but that the F, G, K, and M stars have not yet reached the main sequence. From this information the astronomer can conclude that
Key Concept: How does the mass of a star affect its length of time to becoming a star, and what can this tell us about the age of a star cluster?

102. Two stars are revolving around each other in a binary system. The one star is a 20-solar mass red supergiant while the other luminary is a neutron star. The two stars were at no time in physical contact to exchange any matter with each other. It is fair to say
Key Concept: How does the mass of a star affect the speed of its evolutionary sequence?

103. State in order from smallest to largest the sizes of the following objects that you classified in the homework assignment, "Identify the Celestial Object." Consider a galaxy, a star, a globular cluster, a planetary nebula or supernova, and an open cluster.
Key Concept: Know the relative size differences between stars, galaxies, globular clusters, open clusters, nebulae, and planets.

104-109. In the next five questions you will be presented with images containing one or more of the following objects listed below. Choose the correct object that the picture portrays to receive credit.

a. Star cluster.
b. Spiral galaxy.
c. Globular cluster.
d. Dark nebula.
e. Star field.
f. Elliptical galaxy.
g. Irregular galaxy.
h. Emission nebula.
i. Planetary nebula.
j. Supernova remnant.

Key Concept: Understand what different types of astronomical object look like. Hint: Take these answers and put them into Google images to understand how these images look if you are having trouble with their visualization.