Team Name:_____
Team Number:_____

Astronomy Division C
2014 Solon Invitational

1. What percent of the stars on an H-R diagram are on the main sequence.
A) 10% B) 40% C) 60% D) 80% E) 90%

2. Stars A and B formed at the same time. Star B has 3 times the mass of star A. Star A has an expected lifetime of 3 billion years. What is the expected lifetime of star B?

A) more than 9 billion years
B) about 9 billion years
C) 3 billion years
D) about 1 billion years
E) less than 1 billion years

3. When a star becomes a red giant, it becomes much brighter because it is

A) moving closer to us
B) losing its outer envelope
C) fusing iron in its core
D) increasing in size

4. For a white dwarf to become a nova, it is necessary for it to

A) have a companion star
B) exceed its Chanrasekhar limit
C) have begun life as a high mass star
D) continue the fusion cycle until its core is completely composed of iron.

5. For a star like our sun, once fusion reactions in the main sequence phase stop, the star will next become a:
A. white dwarf. B. black dwarf. C. red giant. D. blue supergiant.

6. In an evolving cluster, which stars become red giants first?

A. Stars with masses like the sun's.
B. Stars with sizes smaller than the sun's.
C. The most massive stars (upper main sequence).
D. The stars with the most heavy elements.

7. During the main-sequence phase of its life, a star fuses:

A. hydrogen to helium in its core.
B. hydrogen to helium in a shell.
C. helium to carbon in its core.
D. helium to carbon in a shell.

8. What is the heaviest element that the most massive stars can fuse in their cores during their normal lives?
A. Helium. B. Oxygen. C. Iron. D. Uranium.

9. Which of these is the MOST IMPORTANT indicator of how a star will evolve?
A. Radius (size). B. Chemical composition. C. Mass. D. Surface temperature.

10. The balance between _____ forces and _____ forces determines the size of a star.

A. radiation/gravitation
B. gravitation/magnetic
C. gravitation/electromagnetic
D. gravitation/convective

11. The main cause of the increased size (radius) of stars as they evolve off of the main sequence is due to:

A. decreased radiation pressure.
B. increased gravitational forces.
C. helium burning in the outer shell of the star.
D. core collapse.

For questions 12-16, match the elements with their role in stellar evolution: (options may be used more than once or not at all)

A. Helium B. Carbon C. Iron D. Gold

____ 12. Chief product of main sequence stars, second most common element.
____ 13. Last common heavy element, has most stably bound nucleus.
____ 14. Formed only during seconds of supernova core collapse.
____ 15. Formed by main sequence stars by fusing four protons together.
____ 16. Acts as a catalyst in hydrogen fusion in cores of hotter stars.

17. In the overall electromagnetic spectrum, consider radio, visible light, and gamma rays in terms of their wavelength. Their correct order, from longest to shortest, is:

A. radio, visible, gamma rays.
B. gamma rays, visible, radio.
C. visible, gamma rays, radio.
D. visible, radio, gamma rays.

18. When you see a spectrum with absorption lines in it, you can infer that:

A. the light passed through ionized atoms.
B. electrons moved up in energy levels to absorb the light.
C. electrons moved down in energy levels to absorb the light.
D. all the atoms were in excited states.

19. Which of these instruments best detects the chemistry of the stars?
A. Charge coupled devices. B. Photometers. C. Spectrographs. D. Bolometers.

20. In making a model of a star, an astronomer does NOT have to know or assume:
A. that the energy given off is produced in the interior.
B. the mass of the star.
C. the chemical composition of the star.
D. the distance to that star.

21. Kepler's third law expresses the square of the period of a planet's orbit in years in terms of a constant times:
A. the average distance from the planet to the sun in astronomical units.
B. the square of the average distance from the planet to the sun in AU.
C. the cube of the average distance from the planet to the sun in AU.
D. the inverse square of its average distance from the sun in AU.

22. Which concept below was NOT part of Kepler's laws?
A. The planet orbits are ellipses.
B. The closer a planet is to the Sun, the faster it moves.
C. Retrograde motion required use of epicycles.
D. The sun lies at one focus of all elliptical planetary orbits.

23. If an asteroid has a period of 8 years, use Kepler's third law to calculate its average distance from the sun in AU.
A. 4 AU. B. 8AU. C. 64AU. D. 512AU.

24. Kepler's third law points out that, among the planets in the solar system, the farther a planet is from the sun, then the:

A. more eccentric is its orbit.
B. slower its orbital speed.
C. faster its orbital speed.
D. more inclined is its orbit.

25. In general, the observed spectra of stars appear as what kind of spectrum?
A. Absorption. B. Continuous. C. Emission. D. Nonthermal.

26. Which of the following properties of stars does NOT require a knowledge of the earth-star distance to find it out?
A. Mass. B. Luminosity. C. Density. D. Surface temperature.

27. Consider two main-sequence stars that have different masses. You can correctly infer that the more massive star will have a:

A. lower luminosity and shorter lifetime.
B. higher luminosity and shorter lifetime.
C. higher luminosity and longer lifetime.
D. lower luminosity and longer lifetime.

28. A star has apparent magnitude of +8.0 before it goes nova and increases its luminosity by 10,000 times. Its apparent magnitude after it goes nova is.
A) +8.0 B) +18.0 C) -8.0 D) -2.0 E) +3.0

29. The brightness magnitude scale for stars is arbitrary with:
A. decreasing number associated with increased luminosity.
B. decreasing number associated with increased wavelength.
C. increasing number associated with increased luminosity.
D. increasing number associated with increased wavelength.

30. Which of these statements is NOT true of the formation of massive stars?
A. They form from material in the giant molecular clouds.
B. They form quickly, in less than a million years.
C. They form in small groups of about 10 stars at a time.
D. They form after the smaller stars like the sun.

31. Which statement about periodic variable is false?
A. They all pulsate.
B. The RR Lyrae variables pulsate with periods of just a few hours.
C. Cepheids pulsate in periods of days to weeks.
D. There is no observable difference between Population I and II Cepheids.

32. You observe two Cepheid variable stars. Star A has a period of 10 days. Star B has a period of 30 days. Which is more luminous?
A) A B) B C) they are the same D) not enough information

33. You observe Cepheid stars in two different galaxies (A and B). They have the same apparent brightness. Star in galaxy A has a period of 10 days. Star in galaxy B has a period of 30 days. Which galaxy is closer?
A) A B) C) they are the same distance D) not enough information

34. Using spectroscopic parallax, you find a star's distance to be 76 parsecs. You now find out that the star isn't a main sequence star, but is a red giant. Your distance estimate is
A) too large B) too small C) fine - no significant change in estimate is needed.

35. What method would be most appropriate to determine the distance to a nearby galaxy?

A) Spectroscopic parallax
B) Cepheid variables
C) Hubble's law
D) Radar ranging

36. What does the Hubble constant measure?

A) The density of galaxies in the universe
B) The luminosity of distant galaxies
C) The rate of expansion of the universe
D) the speed of a galaxy of known redshift
E) the reddening of light by intergalactic dust clouds

37. A cloud fragment too small to collapse into a main sequence star becomes a:

A) pulsar.
B) brown dwarf.
C) white dwarf.
D) planet of another star.
E) T Tauri object.

38. The helium flash converts helium nuclei into
A) carbon B) beryllium C) oxygen D) iron E) boron

39. What forces a star like our Sun to evolve off the main sequence?

A) It loses all its neutrinos, so fusion must cease.
B) It completely runs out of hydrogen.
C) It builds up a core of inert helium.
D) It explodes as a violent nova.
E) It expels a planetary nebula to cool off and release radiation.

40. A surface explosion when a companion spills hydrogen onto its close white dwarf companion creates a:

A) nova.
B) Type I supernova.
C) emission nebula.
D) Type II supernova.
E) planetary nebula.

41. For a white dwarf to explode entirely as a Type I supernova, it must weigh:

A) 20 solar masses, the Hubble Limit.
B) at least 8% as much as the Sun.
C) 1.4 solar masses, the Chandrasekhar Limit.
D) 3 solar masses, the Schwartzchild Limit.
E) 100 solar masses, the most massive known stars.

42. Which of these events is not possible?
A) close binary stars producing recurrent novae explosions
B) white dwarfs and companion stars producing recurrent Type I supernova events
C) red giants exploding as Type II supernovae
D) a white dwarf being found in the center of a planetary nebula
E) low-mass stars swelling up to produce planetary nebulae

43. Which of these variable stars would be classified as a Cepheid?
A) a B supergiant with a period of .14 days
B) an M supergiant with a period of 140 days
C) a K giant with a period of 14 days
D) an F giant with a period of 14 years
E) a G giant with a period of 14 hours

44. The location of the Galactic Center was first found by Harlow Shapley with:
A) Cepheids of population I in the spiral arms.
B) RR Lyrae variables in the globular clusters.
C) planetary nebulae in the open dusters.
D) infrared observations of the heat from its accretion disk around the black hole.
E) radio emissions from Sagittarius A.

45. The period-luminosity relation is critical in finding distances with:

A) Cepheid variables.
B) RR Lyrae stars.
C) pulsars.
D) trigonometric parallaxes.
E) spectroscopic parallaxes.

46. Which of the following are most massive and luminous?

A) white dwarfs
B) Cepheid variables
C) RR Lyrae variables
D) T-Tauri variables
E) brown dwarfs

47. After we can no longer spot Cepheids in the distance, we turn next to:

A) the period-luminosity relation.
B) the Stefan-Boltzman law.
C) the color of the brightest galaxies in the cluster.
D) the light curves of Type II supernovae.
E) the Tully-Fisher relation.

48. Cepheid variable stars are valuable to astronomers because
A) they are the only stars that are known to have planets orbiting them.

B) they come in lots of different colors and contain a diversity of elements, thus giving a good sample of the universe.
C) they can be used to find the distance to the star groups in which they were found.
D) they emit natural radio signals that can be employed in interstellar navigation.

49. The color of a star is MOST DIRECTLY related to its:
A. mass. B. surface temperature. C. central (core) temperature. D. luminosity.

50. The temperature of a star can be found from its

A) spectrum.
B) position in a galaxy.
C) apparent brightness.
D) doppler shift compared to the apparent brightness

51. A star in the main sequence will maintain a constant size
A) as long as its helium supply holds out.
B) because its tendency to contract is opposed by the pressure of the hot interior.
C) until it is devoured by black holes.
D) provided that gravitational collapse does not overwhelm its photosphere.

52. If a star has a parallax of .02" then the distance must be:
A) 20 parsecs B) 50 parsecs C) 100 parsecs D) 200 parsecs

53. For which variable star type is the variability cataclysmic?
A) Cepheid B) Novae C) RR Lyrae D) T Tauri

54. Which option is also known as "Luminous Blue Variables", with Eta Carinae a member of its class?
A) T Tauri B) S Doradus C) W Virginis D) Mira

55. Which option does the DSO V1 belong to?
A) T Tauri B) S Doradus C) W Virginis D) Orion's Nebula

56. The spectrum of a 14^{th} magnitude star places its location on the H-R diagram at 0.0 absolute magnitude. What is the distance to the star in parsecs? (3 pts)

57. A star has a parallax of 0.435 arcsec. What is the distance to this star in light years? (2pts)

58. A Type Ia supernova is discovered in a distant galaxy. At maximum brilliance, the supernova reaches an apparent magnitude of +10. How far away is the galaxy? (4pts)

59. A star is found to have the light curve shown in Image 1. What is the distance to this star, in parsecs? (4pts)

60. The spectral images A through F are in what spectrum:
A) Continuous B) Emission C) Absorption D) Bright-line

61. Using the sample spectra shown in Images A through F, arrange the spectra from coolest to hottest: (3pts)

Coolest _____ _____ _____ _____ _____ _____ Hottest