YUSO 2017 ASTRONOMY EXAMINATION

Part I: Multiple Choice (1 point each)

1. Main-sequence stars fuse which element to form which element?
   a. Helium - Oxygen b. Hydrogen – Helium e. Nitrogen – Oxygen
   c. Hydrogen - Oxygen d. Helium – Nitrogen
2. According to the spectral sequence, what spectral class contains the hottest stars?
   a. G b. O e. B
   c. T d. S
3. To what spectral class does our Sun belong?
   a. G b. O e. B
   c. T d. S
4. What color are the hottest stars?
   a. Red-orange b. Blue e. Yellow-orange
   c. Blue-white d. Yellow
5. What color are the coolest stars?
   a. Red-orange b. Blue-violet e. Yellow-orange
   c. Blue-white d. Yellow
6. The brightest stars are the…?
   a. Smallest and coolest b. Smallest and hottest e. Biggest and hottest
   c. Biggest and coolest d. Biggest and brightest
7. What are redshift and blueshift caused by?
   a. Starbursts b. Doppler Effect e. Movement of stars
   c. Spectral Interim d. Stretching of light waves
8. What are the smallest and densest stars known to exist?
   a. Red giants b. Blue dwarfs e. Neutron stars
   c. White dwarfs d. Quarks
9. If a neutron star has too great a mass, it will continue to collapse and form a/an…
   a. White dwarf b. Atom e. Supernova
   c. Black hole d. Dust cloud
10. Why are Cepheids and RR Lyrae good for finding distances to galaxies?
    a. They are easy to spot with simple software.
    b. They have direct correlations between luminosity and period.
    c. They are the brightest stars in the galaxy.
    d. They don't spin.
    e. They are easy to locate and collect data on.
11. The discovery of what indicated the existence of neutron stars?
    a. Pulsars b. Black holes e. Planetary nebula
    c. Electromagnetic clouds d. White dwarfs
12. A key difference between Type 1a supernovae and the other types are that…?
    a. Type 1a supernovae result from the degeneration of massive stars
    b. Type 1a supernovae can happen in old elliptical galaxies where star formation has ceased
    c. Type 1a supernovae is the only type with hydrogen lines in their spectra
    d. Type 1a supernovae can only have no silicon or helium lines in their spectra
    e. Type 1a supernovae is the only type with oxygen lines in their spectra

13. In a type 1a supernova, what happens when a white dwarf accretes enough mass to exceed the Chandrasekhar limit?

a. Gets bigger and colder b. Collapses into a neutron star e. Nothing
c. Turns into a type II supernovae d. A black hole is formed

14. Which is a progenitor of a Type 1a supernova?

a. A gaseous stellar nursery b. A young massive supergiant star e. Gravity
c. An old massive supergiant star d. A white dwarf in a close binary system

15. Life stages of a star depend on…?

a. The initial mass of a star b. The temperature of a star e. The elements being fused
c. The location of a star d. The surrounding stars

16. The brightness of a star as seen from Earth is its…?

a. Absolute magnitude b. Apparent magnitude e. Temperature
c. Luminosity d. Spectrum

17. What is the term that refers to the actual brightness of a star?

a. Absolute magnitude b. Apparent magnitude e. Temperature
c. Luminosity d. Spectrum

18. What is the law that states everything is moving away from us with a speed that is proportional to its distance?

a. Kepler's law of motion b. Big Bang Theory e. Kirchoff's Law
c. Chargaff's Law d. Hubble Law

19. What is the term that refers to a decrease in wavelength and an increase in frequency of an electromagnetic wave?

a. Blueshift b. Stellar shift e. Wavelength shift
c. Waveshift d. Redshift

20. What is the term that describes an increase in wavelength and a decrease in frequency of an electromagnetic wave?

a. Blueshift b. Stellar shift e. Wavelength shift
c. Waveshift d. Redshift

21. What is the term that refers to the change in frequency due to the motion of the source or the receiver?

a. Frequency shift b. Wavelength shift e. Doppler effect
c. Motion effect d. Absorption effect

22. What is the term for stars in the process of formation?

a. Gemnistars b. Protostars e. Pre-stars
c. Main-sequence stars d. Dwarf stars

23. What is the tool used to measure the light emitted by a star at optical wavelengths.

a. Optophotograph b. Sphygmomanometer e. Photometron
c. Telescope d. Spectrograph

24. What type of star that has high luminosity and low surface temperature?

a. White dwarf b. Red giant e. Blue dwarf
c. Main sequence star d. Brown dwarf

25. What type of star that is the collapsed core of a large star that ranged from 10 to 29 solar masses?

a. Protostar b. T Tauri star e. White dwarf
c. Neutron star d. Red dwarf

26. A _____ is a highly magnetized, rotating neutron star that emits a beam of electromagnetic radiation.

a. Radiotron b. Nucleoton e. Electron
c. White dwarf d. Pulsar

27. What are objects that give a certain, known amount of light referred as?
    a. Standard light b. Standard DSOs e. Standard candles
    c. Base points d. Standard beacons
28. What is the explosion point of a white dwarf referred as?
    a. Chandrasekhar limit b. Turnoff point e. Explosion point
    c. Breaking point d. Solar limit
29. What is an explosion of a massive supergiant star called?
    a. Kaboom b. Meteor shower e. Giant shower
    c. Supernova d. Nebula
30. What is the stage that stars spend majority of their lives at?
    a. Protostar b. Planetray nebula e. Mira
    c. Main sequence d. Red giant
31. What is the cloud of matter from which stars originate?
    a. Molecular cloud b. Proton cloud e. Dark matter
    c. Gaseous cloud d. Nebular stratosphere
32. What are pre-main-sequence variable stars with spectral classes from F to M called?
    a. Mira variable stars b. Protostars e. T Tauri stars
    c. Pre-stars d. Pulsars
33. What is the term for a strong outflow of a star's mass during thermal pulses?
    a. Strong wind b. Gas wind e. Thermal wind
    c. Stellar wind d. Stellar gas
34. What is the point at which the stars deviate from the main sequence after using up most of their fuel?
    a. Chandrasekhar limit b. Turnoff point e. Runoff point
    c. Breaking point d. Solar limit
35. What is the term that refers to the amount of light that comes from a certain area (usually $1 m^2$)?
    a. Luminosity b. Brightness e. Flux
    c. Light area d. Intensity
36. Each element has a characteristic _____.
    a. Wavelength b. Frequency e. Spectra
    c. Light area d. Intensity
37. Most of the stars in the universe are _____.
    a. Protostars b. in a planetary nebula e. Main sequence stars
    c. T Tauri stars d. Mira variable stars
38. Edwin Hubble showed that the recession velocity is proportional to _____.
    a. Mass b. Distance e. Temperature
    c. Luminosity d. Wavelength
39. The principle of homogeneity or uniformity stated that the universe is the _____ everywhere.
    a. Same b. Center of e. Source of
    c. Container of d. Creation of
40. Gas pressure and densities are much lower in giant stars than dwarfs.
    a. True b. False
41. When a star is in free-fall collapse, it is a protostar.
    a. True b. False
42. A star becomes a main sequence star when it is obtaining all its radiated energy from nuclear fusion of hydrogen to oxygen.
    a. True b. False

43. Stars with masses less than .08 solar masses cannot reach the main sequence.
    a. True b. False
44. How long a star remains in main sequence depends on its temperature.
    a. True b. False
45. Low-mass stars go through their life-cycle faster than their higher-mass stars because the less mass, the faster the rate of fusion.
    a. True b. False
46. When comparing two separate binary systems of the same separation distance, the two stars in the binary system that has a larger combined mass will move faster than the two stars in the binary system with less combined mass.
    a. True b. False
47. About how much iron is ejected by a type 1a supernova?
    a. 3 solar masses b. .5 solar masses e. 1 solar mass
    c. 2 solar masses d. 1.4 solar masses
48. What is the initial surface temperature of a neutron star?
    a. Very hot b. $1*10^{22}$ K e. That has not been discovered yet.
    c. $1*10^{6}$ K d. $1*10^{10}$ K
49. Protostars less massive than 0.08 solar masses become…?
    a. Neutron stars b. White dwarfs e. Red giants
    c. Mira variable stars d. Brown dwarfs
50. If a protostar rotates too rapidly, what happens?
    a. Breaks apart into two protostars obiting each other
    b. Explodes into a supernova
    c. Gravitational pull increases and the core forms into a black hole
    d. Heats up and becomes a red giant
    e. It loses mass
51. The total flux of a star is also known as…?
a. Total flux b. Absolute magnitude e. Bolometric flux
c. Luminosity d. Absolute flux

Part II: DSO Identification (2 pts each)

The questions 1-5 correspond to the five pictures on the DSO Image List.

1. Identify DSO #1 on the Image List.
    a. Which telescope was used to take this image?
    b. Which constellation is this DSO located in?
    c. What gas is causing the green color?
    d. What gas is causing the red color?
    e. What gas is causing the blue color?
2. Identify DSO #2 on the Image List:
    a. Which constellation is this DSO located in?
    b. Which star of this binary star system is more massive?
    c. What is the more massive star's distance modulus?
    d. What spectral class does the more massive star belong to?
    e. What is the average separation of this binary star system?
3. Identify DSO #3 on the Image List.
    a. In which constellation is this DSO located?

b. How long is the period of revolution?
c. What is this DSO's right ascension and declination?

4. Identify DSO #4 on the Image List.
   a. Which constellation is this DSO located in?
   b. Which astronomer was this DSO named after?
   c. About how old is this DSO?
   d. How many variable stars does this DSO contain?
   e. How many known pulsars does this DSO contain?
5. Identify DSO #5 on the Image List.
   a. Which constellation is this DSO located in?
   b. Approximately how far is this DSO from Earth in light years?
   c. Why was the explosion not visible from Earth a century ago?
   d. When was it discovered?
   e. What makes this DSO different from other DSOs like it?
   f. What is most of the X-ray emission from this DSO made up of?
6. From the image list, which image(s) are artist's impressions?
7. Out of the Science Olympiad 2017 DSO list, which planetary nebula is the youngest?
8. Out of the Science Olympiad 2017 DSO list, which one was the first globular cluster in which a planetary nebula could be identified?
9. Out of the Science Olympiad 2017 DSO list, which DSO contains at its center one of the hottest known white dwarfs? What is the surface temperature of that dwarf?
10. What is the spectral type of Mira A?
11. Out of the Science Olympiad 2017 DSO list, which DSO was observed in 1572?
12. Out of the Science Olympiad 2017 DSO list, which DSO is in the Pinwheel Galaxy?
13. Out of the Science Olympiad 2017 DSO list, which DSO is expanding at more than 5,000 km/s?
14. As the orbit between J075141 & J174140, what do scientists predict will happen? 15. Out of the Science Olympiad 2017 DSO list, which DSO exhibits the light curve on the attached page (Fig. 1)?
16. Out of the Science Olympiad 2017 DSO list, which DSO is located in the Gemini constellation?
17. Out of the Science Olympiad 2017 DSO list, which DSO has an apparent magnitude of 10.75?
18. What is the closest star system to Earth?
19. What star was the first white dwarf discovered? When was it discovered? Who discovered it?

Part III: Short answer (2 pts each)

1. What is the order of the spectral class of stars from hottest to coldest?
2. In which spectral class(es) do hydrogen absorption lines appear strongly?
3. What spectral class are most main sequence stars in?
4. What two kinds of information about a star's outer atmosphere can you extract from a spectrum?
5. State Kepler's 1st law of planetary motion:
6. State Kepler's 2nd law of planetary motion:
7. State Kepler's 3rd law of planetary motion:

Questions 8-11 refer to the image on the attached page (Fig. 2)

8. What does each dot on the H-R diagram represent?
9. What does the red line represent?
10. Mass, brightness, and temperature of main-sequence stars increase in which direction?
11. What spectral class is the star that is marked by the red "x"?
12. In the Yerkes classification scheme, stars are assigned to groups according to

13. What are accretion disks also known as?
14. Name 5 ways to determine distance in space:

Part IV: Math (3 pts each)

You must show work in order to receive credit. Please use units, circle your answers, and round answers to 3 sig. figs.

1. Consider an object of .2 solar masses orbiting the Sun. The object's orbit has a semimajor axis of 6 AU.
    a. How long is its period in years?
    b. Consider the points A, B, C, D on the orbit of the object. The arc length from point A to point B is .225 AU. The arc length from point C to D is .556 AU. How much time does it take the object to move from point A to point B compared to the time it takes to get from point C to point D?
    c. What shape is its orbit?
2. Consider a binary system: Star A has a solar mass of 1.00. Star B has a solar mass of 12.0. Their mean separation is 60.0 A.U.
    a. What is the position of the center of mass of the binary system relative to star A?
    b. What is the position of the center of mass of the binary system relative to star B?
    c. In years, what is the time period of rotation of the binary star system?
    d. If Star A is a white dwarf, what mass must it reach to create a type 1a supernova?
    e. If star A is 3 times as hot as star B, then it emits how much more energy?
    f. If star A is 3 times as hot as star B and its radius is 1/8 of star B's, how does star A's luminosity compare to star B's?
    g. Consider a binary system in a neighboring galaxy that contains star C and star D. If star C has a solar mass of .8 and star D has a solar mass of 15.0. Which binary system has a greater gravity force acting between the two stars? Why?
3. You have discovered what you think is a type 1a supernova. You have calculated that the apparent magnitude is +20.0.
    a. How far from Earth, in parsecs, is this supernova?
    b. In light years?

Part V: Tiebreaker Questions

You must show work in order to receive credit. Please use units and round answers to 3 sig. figs.

1. What have researchers recently possibly discovered by studying objects in the Kuiper Belt that could be the explanation behind the tilting of our solar system by about 6 degrees?
2. How many pennies would you need to string together to make a belt of pennies for the Earth?
3. You realize how much work that would take and decide to cash the pennies instead. How much money, in dollars, would you have?
4. Why are there no green or purple stars?