Astronomy – EXAM

2022 UMD Invitational

Team Number: _____

Team/School Name: ____________________________________

No abbreviations / PRINT LEGIBLY

Student Names (First & Last): PRINT LEGIBLY

1. ____

2. ____

Total Points Possible (120): **insert total # of points**

Total Points Earned:__________

Team Number: ___________ School Name: ________________________________

Part I - General Knowledge (40)

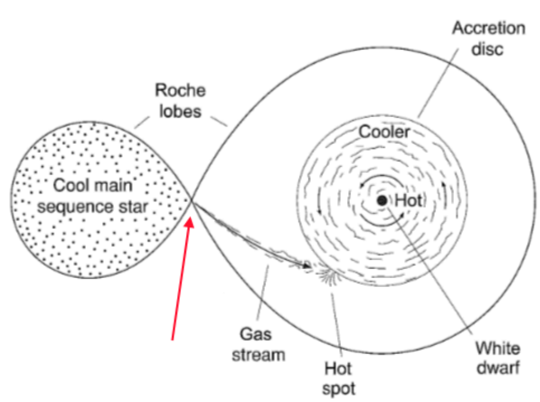
1. Protostars are shrouded by the gas and dust of the region they form in, blocking certain wavelengths. What is the primary wavelength used to study these objects?
    a. Visible
    b. Radio
    c. Ultraviolet
    d. Infrared

2. Brown dwarfs are star-like objects that never reached quite enough mass to begin stellar fusion. Instead, what mechanism powers their radiation?
    a. Rotational slowing
    b. Stellar fission
    c. Photon absorption
    d. Gravitational contraction

3. Carbon stars fall closest to which stage in a low-mass star's life cycle?
    a. Protostar
    b. Main sequence
    c. Red giant
    d. White dwarf

4. Planetary nebulae have a misleading name for their true nature. Where did their name come from?
    a. Their resemblance to planetary discs
    b. The high number of planetary objects found in the nebula
    c. Their orbits that make them galactic "planets"
    d. The high amount of protoplanetary material swept up by the nebula

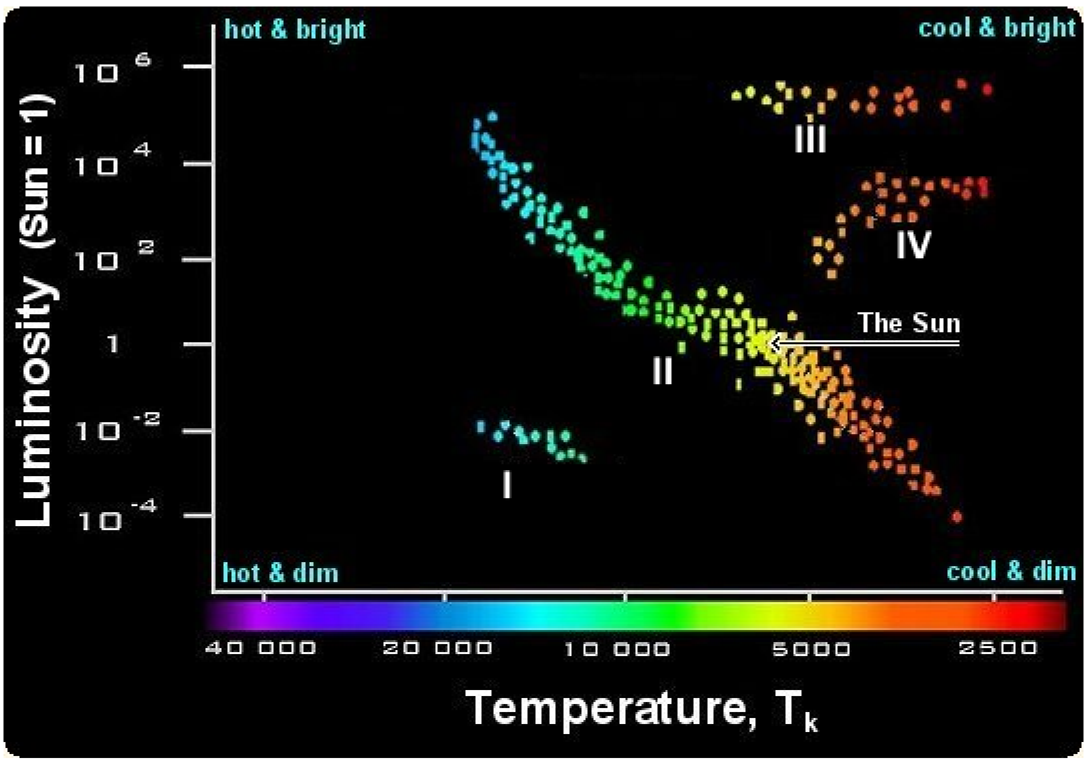
5. A model of a cataclysmic variable (CV) system is shown to the right. What point is the red arrow showing?
    a. The binary's barycenter
    b. The Roche knot
    c. The binary's Lagrange point
    d. The Chandrashekar node



6. What would be the best observation pattern for a dwarf nova event?
    a. Day long regular observation
    b. Month long regular observation
    c. Year long regular observation
    d. Year long irregular observation

7. Some CVs see repeated outbursts of novae. What are these referred to as?
    a. Periodic nova
    b. Recurrent nova
    c. Repeated nova
    d. Oscillatory nova

Questions 8-10 refer to the following image. Each numeral references the region of stars clustered most closely to it.



8. The x- and y-axes of the HR Diagram can be labeled with two different but equivalent values. What are these?
    a. Stellar class, absolute magnitude
    b. Stellar mass, absolute magnitude
    c. Stellar class, apparent magnitude
    d. Stellar mass, apparent magnitude

9. In which region would we find stars no longer undergoing stellar fusion?
    a. I
    b. II
    c. III
    d. IV

10. Which regions would a low-mass star visit during its life cycle?
    a. I, II
    b. II, III, IV
    c. I, II, IV
    d. All regions

11. In order of low to high surface temperature, what are the stellar classes?
    a. M, K, G, F, A, B, O
    b. F, K, M, G, A, O, B
    c. L, Y, G, K, A, B, O
    d. Y, L, B, A, K, O, G

12. In the Harvard classification scheme, there are three components to a star's class, such as in our Sun: G2V. What is the third component of this classification?
    a. Spectral sub-class
    b. Absorption line peculiarities
    c. Luminosity class
    d. Emission features

13. In stellar spectra, absorption lines are much more easily observed than emission lines. Why is this?
    a. Stars have weak emission lines
    b. Stars emit at all wavelengths
    c. Emission lines are blocked by stellar atmospheres
    d. Emission lines are broadened by stellar rotation and made indistinguishable

14. In general, the size of telescopes is related to its observational wavelength. Which wavelength has the largest dedicated telescopes?
    a. X-Ray
    b. Visible
    c. Infrared
    d. Radio

15. Over history, some constellations have been lost and are no longer defined by the IAU. Why is this?
    a. Some stars have moved or changed in brightness, erasing old constellations
    b. As constellations have become more professionally defined, some were not considered to be recognizable enough
    c. Constellations are now mainly used for regions of the sky, meaning some have been dropped to avoid overlap
    d. Some constellations were redundant and included the same stars and as such were dropped

16. Which stars have brightness variations caused by instabilities in their accretion disks?
    a. RR Lyrae variables
    b. Mira variables
    c. T Tauri variables
    d. Cepheid variables

17. What is the name for the cutoff mass that determines whether a white dwarf will collapse and initiate a Type Ia supernova?
    a. Russell Limit
    b. Chandrasekhar Limit
    c. Tolman-Oppenheimer-Volkoff Limit
    d. Boltzmann Limit

18. What differentiates Herbig-Haro objects from other star formation regions?
    a. Strong hydrogen alpha lines
    b. Supernova remnants
    c. High metallicity
    d. Ionized gas jets

19. RR Lyrae variables obey a period-luminosity relationship in which electromagnetic band?
    a. Radio
    b. Infrared
    c. Visible
    d. X-ray

20. Ionized hydrogen is responsible for the brightness oscillations found in:
    a. RR Lyrae variables
    b. Mira variables
    c. T Tauri variables
    d. Cepheid variables

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Part II - DSOs (40)

1. The following questions consider all DSOs. They are provided below for convenience. Not all need to be used, and some may be used multiple times. (8)

   i. **HOPS 383**
   ii. **HH 24-26**
   iii. **V1331 Cyg**
   iv. **HBC 672**
   v. **Orion Nebula**
   vi. **Alpha Tauri**
   vii. **RR Lyrae**
   viii. **Omicron Ceti**
   ix. **ESO 577-24**
   x. **IC 4593**
   xi. **U Antliae**
   xii. **LP 40-365**
   xiii. **ASASSN-16oh**
   xiv. **V Sagittae**
   xv. **AR Scorpii**
   xvi. **SDSS 1035+0551**
   xvii. **Tycho's SNR**

   a. Which DSOs are variable stars? (2)

   b. Which DSOs are nebulae/clouds? (2)

   c. Which DSOs are <u>individual former</u> main sequence stars? (2)

   d. Which DSOs are <u>individual current or pre-</u>main sequence stars? (2)

2. The following questions refer to the image below. (7)

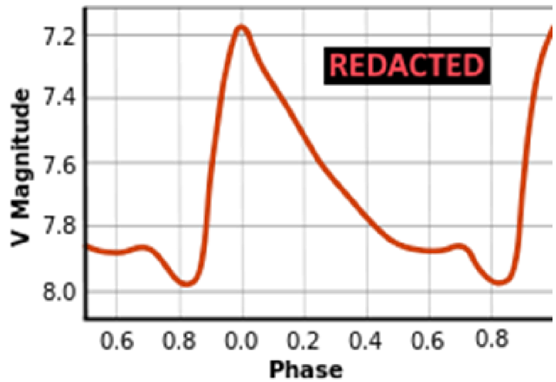
   a. Which DSO (or member of a DSO) is shown in this picture? (1)

   b. What telescope took this image, and is it ground-based or space-based? (2)

c. The name of this object contains two parts. What does each refer to? (2)

d. What does the presence of this/these objects reveal about this region? (2)

3. The following questions refer to the image below. (8)



a. What does this chart show, and what DSOs would likely have a chart (with a different shape perhaps) like this? (2)

b. Does this chart reflect a specific DSO, and if so, which one? (2)

c. For the DSOs from (a), what type of objects are each/all? (2)

d. There are a couple other DSOs that are generally categorized along with those from (a). What are they, and what main difference separates these objects and those mentioned before? (2)

4. The following questions refer to the image below. (8)

a. Although this image is meant to depict a specific object, it is similar to three DSOs on our list. Which are those? (2)

b. All of these DSOs were once the same type of object, although now two of them are “dead” or feature new characteristics. What is this type, and which specific DSOs are no longer of that type or are “dead?” (2)

c. One of the DSOs from (b) mimics another kind of object, pulsars, and are currently the only one of their kind known. What makes it different from a pulsar, and what key observation revealed its nature? (2)

d. The other DSO from (b) is considered to be a “dead” version of its former type. Why was its discovery so important? (2)

5. The following questions refer to the following image. (4)

a. What DSO is shown in this picture, and what type of object is it? (2)

b. What telescope took this image, and what wavelengths are it in (the telescope should tell you this!)? (2)

6. Names of objects in astronomy vary wildly based on the circumstances of its discovery. The following questions are all about the names of objects on the DSO list and their meaning. (5)

a. On this list, the three general types of names are referenced by the survey the object was found in, the type of the object, or the constellation the object lies in. Name one example of each. (2)

b. What are two surveys reflected in the names of these DSOs (the full name of the survey)? (2)

c. Why do some of these objects have several names, while others have few or only one? (1)

Part III - Math (40)

Constants

Use the following constants for your problems:

Speed of Light (c): $3.00*10^8$ m/s
Hubble Constant (H_0): 70 km/s/Mpc
Gravitational Constant (G): $6.67*10^{-11}$ $m^3/kg/s^2$
Wien's Displacement Constant (λ): $2.897*10^6$ nm*K
Stefan-Boltzmann Constant (σ): $5.67*10^{-8}$ $W/m^2/K^4$

1. A Type Ia Supernova is detected with a peak apparent magnitude of 8.95. (10)
   a. What is the absolute magnitude of a typical Type Ia supernova? (2)

      Answer: _______________________

   b. Using your answer from a, determine the distance to the supernova in megaparsecs. (4)

      Answer: _______________________

   c. Using your answer from part b and Hubble's Law, calculate the recessional velocity of the supernova in km/s (4)

      Answer: _______________________

2. A star has a peak emission wavelength of 764 nm and a parallax of 0.0438 arcseconds. (20)
    a. Determine the distance of the star from Earth in parsecs (3)

       Answer: __________________________
    b. Determine the temperature of the star in Kelvin (3)

       Answer: __________________________

    c. Using your previous answer, calculate the star's irradiance, in W/m^2 (4).

Answer: ________________________

d. The star's angular radius is 60.98 milliarcseconds. Using your answer from part a, calculate the star's actual radius, in km (4).

Answer: ________________________

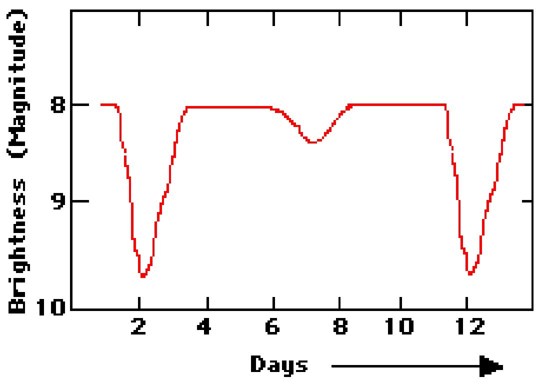
e. Using your answers from parts c and d, determine the star's total luminosity in **solar luminosities.** The luminosity of the sun is $3.827*10^{26}$ W (5).

Answer: ________________________

f. Based on the star's luminosity and temperature, what type of star is it? (1)

Answer: ________________________

3. Consider a binary star system in a circular orbit. Star A orbits 0.1 AU from the center of mass, while Star B is 0.2 AU from the center. Below is the light curve for the system. (10)



a. Determine the period of the system in days (round to the nearest whole number) (2)

   Answer: ___________________________

b. Calculate the mass of the system in solar masses (*Hint: Pay attention to units!)* (4)

   Answer: ___________________________

c. Calculate the mass of each star (4)

   Star A: _____________________ Star B: ___________________________